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TRANSACTIONS

OF THE

INTERNATIONAL ENGINEERING CONGRESS, 1915

INDEX VOLUME

SESSIONS HELD UNDER THE AUSPICES OF

American Society of Civil Engineers
American Institute of Mining Engineers
The American Society of Mechanical Engineers
American Institute of Electrical Engineers
The Society of Naval Architects and Marine Engineers

SAN FRANCISCO, CALIFORNIA, SEPTEMBER 20-25, 1915

The Committee of Management of the Congress does not assume responsibility for any of the statements made or opinions advanced in the published transactions

SAN FRANCISCO, CALIFORNIA

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PREFACE

This volume, which in the announcements concerning the Congress has been designated as the "Index Volume", is divided into three sections:

I. Historical and Statistical.
II. Abstracts of Papers.
III. Table of Contents and Author Index.

Section I contains the following:

(1) A brief history of the inception and development of the Congress.
(2) An outline of the organization under which it was conducted.
(3) Names of the officers, membership of the various committees, names of delegates, registered members, and contributors to the guarantee fund subscribed by the engineers of the Pacific Coast.
(4) Full reports of the opening and closing general sessions of the Congress.
(5) Certain statistical matter relating to its transactions, membership and finances.

Section II contains a brief abstract of the subject matter of each paper published in the transactions.

Section III contains a table of contents of each of the eleven volumes of the transactions, together with an alphabetical author index which includes also the names of those who took part in the discussions.

The historical and statistical matter which appears in Section I is presented for the double purpose:

First: of giving to the members of the Congress, the supporting societies and the profession at large, as a matter of general professional interest, as clear an indication as possible of the origin, character and purpose of the Congress, the nature of the organization under which it was conducted and the amount of work involved.

Second: to serve, in some measure, as a guide to those who may be called upon in the future to conduct a similar congress.

It will be readily appreciated that it is not possible to mention even the names of the many individuals who have contributed in varying degrees to the success of the Congress, still less to give to each the proper credit for services rendered, and no attempt has been made to do so.

While the bulk of the work of the Congress has naturally fallen upon the members of the Committee of Management, they have been greatly assisted by many engineers and others outside of its membership, both in this country and abroad, and the Committee takes this opportunity of expressing to all such, as well as to the contributors of papers and discussions, its appreciation of and thanks for the aid and support which they have generously given to the undertaking.

THE COMMITTEE OF MANAGEMENT.

W. A. Cattell,
Secretary-Treasurer.

W. F. Durand,
Chairman.

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SECTION I. HISTORICAL AND STATISTICAL

HISTORICAL SKETCH OF THE DEVELOPMENT OF THE CONGRESS FROM ITS INCEPTION TO THE ORGANIZATION OF THE PERMANENT COMMITTEE OF MANAGEMENT

Inception and Development

When it was determined that there should be an International Exposition in San Francisco in 1915 to celebrate the opening of the Panama Canal, engineers throughout the United States, more especially in California, began to consider the possibilities of holding an Engineering Congress at the same time. It seemed appropriate that a great engineering achievement of international importance should be celebrated by an international gathering of engineers; and, if engineers here and there thought simultaneously of the same thing, it was because it was in the air and because it seemed appropriate and fitting to the occasion.

Credit for the inception of the Congress does not belong to any one man or to any one group of men. It was conceived by many, and in its accomplishment is the result of the united and harmonious efforts, not only of many individuals, but of five great national organizations.

The First Meeting

Suggestions were made here and there, but the movement in San Francisco which resulted in the International Engineering Congress of 1915 began to take definite shape at a meeting of representatives of the American Societies of Civil and Mechanical Engineers, which was held on October 24, 1911.

There were present at this meeting Messrs. A. L. Adams, C. Derleth, Jr., and C. E. Grunsky, representing the American Society of Civil Engineers, and Messrs. G. W. Dickie, E. C. Jones and T. W. Ransom, representing The American Society

of Mechanical Engineers. Mr. Derleth acted as Chairman, and Mr. Ransom as Secretary.

At this meeting the definite determination was reached that an Engineering Congress should be held in San Francisco in 1915, and invitations were extended to all engineering and technical societies represented by local organizations in San Francisco to be represented by delegates at a meeting to be held on Nov. 2, 1911, to discuss "ways and means".

The Meeting of November 2, 1911

At this meeting of Nov. 2, eight engineering and technical societies were represented, as follows:

(1) American Society of Civil Engineers by C. Derleth, Jr., and C. E. Grunsky.

(2) The American Society of Mechanical Engineers by G. W. Dickie, E. C. Jones and T. W. Ransom.

(3) Pacific Coast Gas Association by E. C. Jones.

(4) American Institute of Electrical Engineers by H. A. Lardner.

(5) Mining and Metallurgical Society of America by F. W. Bradley and S. B. Christy.

(6) American Institute of Mining Engineers by W. C. Ralston and E. T. Blake.

(7) American Chemical Society by F. T. Green and B. S. Drake.

(8) Technical Society of the Pacific Coast by Marsden Manson and Otto von Geldern.

As a result of the deliberations of this meeting, a resolution was adopted that each society represented, together with others to be invited, should send three delegates to a conference to be held on Jan. 15, 1912, "for the purpose of formulating plans for holding an International Engineering Congress in conjunction with the Panama-Pacific Exposition in San Francisco during the year 1915."

The Conference of January 15, 1912

At the conference of January 15, which was held in accordance with the foregoing, nine different societies were represented by the following delegates:

American Society of Civil Engineers—
A. D. Foote
C. D. Marx
W. A. Cattell;

The American Society of Mechanical Engineers—
Calvin W. Rice
W. F. Durand
E. C. Jones;

Pacific Coast Gas Association—
John A. Britton
C. O. G. Miller
Frank A. Leach, Jr.;

American Society for Testing Materials—
C. B. Wing
Loren E. Hunt
C. F. Wieland;

The Society of Naval Architects and Marine Engineers—
W. F. Durand
F. W. Hibbs
Geo. W. Dickie;

Mining and Metallurgical Society of America—
F. W. Bradley
C. W. Merrill
Ed. A. Benjamin;

American Institute of Mining Engineers—
W. C. Ralston
Edwin Blake
S. B. Christy;

American Society of Electrical Engineers—
H. A. Lardner
S. J. Lisberger
Geo. R. Murphy;

Technical Society of the Pacific Coast—
Otto von Geldern
Marsden Manson
W. H. Heuer.

It will be noted that at this meeting of Jan. 15, two societies were represented which had not had representation at the meeting of Nov. 2, viz., the American Society for Testing Materials and The Society of Naval Architects and Marine Engineers; while the American Chemical Society, which had been represented at the earlier meeting, did not send delegates to the latter.

The meeting was called to order by Prof. Charles Derleth, Jr., Mr. T. W. Ransom acting as Secretary. Prof. W. F. Durand was elected Chairman and Mr. Otto von Geldern, Secretary of the conference. Messrs. Derleth, Grunsky and Ransom were elected delegates at large.

A committee was appointed, consisting of Messrs. C. D. Marx, S. B. Christy, W. F. Durand, H. A. Lardner, G. W. Dickie, C. B. Wing and F. W. Bradley, to formulate a definite plan of organization.

The First Suggested Plan for the Congress

This committee proceeded without delay, and on January 29, reported to an adjourned meeting of the conference of January 15 a general plan of organization and procedure which contemplated "a series of meetings of the various American national societies with the participation or coöperation of foreign societies of similar standing, held in one place and with such relation or sequence in time as may best serve the convenience of those desiring to attend". Each participating society was to issue invitations to foreign societies in its own name, to be responsible for procuring papers appropriate to its field, and likewise for the editing and publishing of such papers in its transactions, or otherwise, and as it might select. In addition to these meetings of the individual societies, which were to have no coherence other than a certain arrangement of time and sequence, certain joint or mass meetings were to be arranged, at which papers of a general nature were to be presented.

This plan did not meet with the approval of the governing bodies of the national societies, and in a letter dated April 18, 1912, Mr. Charles Warren Hunt, Secretary of the American Society of Civil Engineers, pointed out that a plan to carry on a congress under the management of a committee

consisting of representatives of the national societies would probably meet with the approval of these bodies, and that if the engineers on the Pacific Coast would, themselves, raise a guaranty fund approximating $10,000, the balance of the required guarantee would doubtless be underwritten by the five societies.

The Plan Adopted

As subsequently developed, the plan suggested by Mr. Hunt contemplated as its general features:—

(1) That five national societies, viz., the American Society of Civil Engineers, the American Institute of Mining Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers and The Society of Naval Architects and Marine Engineers, be asked to endorse the movement and participate in the underwriting of the expenses.

(2) That an organization or Committee of Management should be formed to conduct the Congress, consisting of six representatives from each of these five societies, viz., the president and secretary of each society and four other members from each, resident in or near San Francisco.

(3) That the expenses be underwritten on the basis of $10,000 by the Engineers of the Pacific Coast, and the balance by the five societies in proportion to the respective membership of each society.

On the committee appointed to formulate the plan of organization, two other societies, viz., the American Society for Testing Materials and the Mining and Metallurgical Society of America, had been represented; but it was thought best to limit representation on the final Committee of Management to the five societies, as nearly all the members of other societies were also members of one or more of the five.

The Guaranty Fund

In the negotiations between the delegates and the national societies which followed the conference of January 15, 1912, it soon became evident that to enlist the active support of the national societies, it would be necessary for the local engineers to show their faith in the project by themselves raising a guarantee fund of not less than $10,000.

To this undertaking they proceeded without delay, and the appeal was made not alone to the engineers of San Francisco or California, but to the engineers of the entire Pacific Coast from Seattle to San Diego, as a matter in which every engineer, and in fact every resident on the Pacific Coast, should take a vital interest. This appeal, it should also be observed, was not made to the members of any one society or group of engineers alone, but to the members of all engineering and technical societies in all branches of the profession.

The response was most gratifying, and when the Committee of Management met on March 6, 1913, to perfect its permanent organization, the guaranty fund of $10,000 had been fully subscribed, the individual subscriptions ranging from $2.50 to $400.00.*

During this period of nearly fifteen months from January 1912 to March 1913, Mr. Otto von Geldern was the secretary of the preliminary organization growing out of the conference of Jan. 15, 1912, and which had in hand the securing of subscriptions to this guarantee fund, and to Mr. von Geldern is entitled the larger share of the credit for securing these subscriptions.

Without this guaranty fund, the International Engineering Congress of 1915 would never have been realized, and it is therefore to the collective faith and courage of the engineers of the Pacific Coast that the engineering profession is primarily indebted for the Congress and for the lasting benefits which will spring from it.

With the guaranty fund of $10,000 fully underwritten by the engineers of the Pacific Coast, the five national societies readily undertook to underwrite the balance of the total amount, which it was estimated might be necessary to meet the possible maximum difference between receipts and expenditures. This total amount was estimated at approximately $35,000 and the final underwriting was as follows:

* For names of contributors to the guarantee fund see page 117.

Engineers of the Pacific Coast	$10,000
American Society of Civil Engineers	9,000
American Institute of Min. Engineers	5,000
The American Society of Mech. Engineers	5,000
American Institute of Elec. Engineers	5,000
The Society of Naval Architects and Marine Engineers	2,000
A total of	$36,000

The amounts underwritten by the five societies are approximately proportionate to their respective memberships.*

Final Organization of the Committee of Management

The general plan as outlined above was submitted to and received the approval of each of the five societies, and on March 6, 1913, the local members of the Committee of Management appointed by these societies met in the board-room of the Mechanics' Institute for the purpose of perfecting a permanent organization.

There were present at this meeting† Messrs. A. L. Adams, H. F. Bain, W. A. Cattell, W. G. Dodd, W. F. Durand, A. M. Hunt, C. D. Marx and C. R. Weymouth. The meeting was called to order by Prof. W. F. Durand, acting as chairman of the conference of January 15, 1912. Professor Durand was elected temporary chairman, and W. A. Cattell temporary secretary of the permanent organization. A committee was appointed consisting of Chairman W. F. Durand, ex officio; W. A. Cattell, E. H. Benjamin, T. W. Ransom, A. M. Hunt and W. G. Dodd—the last five representing, respectively, the American Society of

* Owing to the fact that the Am. Inst. of E. E. was committed to the holding of an International Electrical Congress in San Francisco in 1915, it did not feel that it should assume its full proportion in underwriting the guarantee fund. It agreed, however, to underwrite $3500 and, at its own suggestion, to be represented on the Committee of Management by two instead of four appointive members.

After the abandonment of the International Electrical Congress, the Am. Inst. E. E. increased its underwriting subscription to $5000 and was thereafter represented by four appointive members on the Committee of Management.

† For complete list of the members of the Committee of Management at this date see p. 20.

Civil Engineers, the American Institute of Mining Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers and The Society of Naval Architects and Marine Engineers—to formulate a definite plan for the permanent organization of the committee, to nominate permanent officers and report at a meeting to be held on March 14, 1913.

At this meeting of March 14, the plan of organization, together with the constitution and by-laws for the government of the Committee on Management, which was submitted by the sub-committee appointed at the previous meeting, was adopted; Prof. W. F. Durand was elected permanent Chairman and W. A. Cattell permanent Secretary-Treasurer of the committee.

Sub-Committees

The plan of organization of the Committee of Management provided that the presidents and secretaries of the five supporting societies should form a sub-committee on participation, to act largely in matters pertaining to the invitation of foreign societies, the selection of honorary officers and the reception of visiting officers, delegates and members.

The actual work of organizing and conducting the Congress was to be handled by the local members of the committee in San Francisco. This work was divided among five sub-committees, and on March 15, 1913, Chairman Durand appointed the following as chairmen of the various sub-committees:*

Executive	W. F. Durand
Finance	W. G. Dodd
Papers	A. M. Hunt
Publicity	W. A. Cattell
Local Affairs	E. H. Benjamin

The Executive Secretary

It was realized from the start that in addition to such work as could be performed gratuitously by the members of the committee, it would be necessary to employ an executive secretary, who could give his entire time to the supervision of the vast amount of clerical, editorial and publication work which would be involved.

* For full list of members of sub-committees see p. 23.

After careful deliberation on the part of the committee, it was decided as a matter of policy that the executive secretary should be selected from outside of the ranks of the engineering profession, that he should be chosen for his executive and linguistic abilities, rather than for technical knowledge, which, it was thought, could best be supplied by the members of the committee, all of whom were engineers. Accordingly, Mr. E. J. Dupuy, born in San Francisco and educated in France, and a man of large and varied experiences in educational and executive work in both countries, was appointed to this office. The results have abundantly justified both the adoption of the policy and the selection of the man.

Executive Offices

On April 1, 1913, the executive offices of the Committee of Management were established in the Foxcroft Building, San Francisco, and the final stage of the active work of preparation for the Congress commenced.

THE WORK OF THE COMMITTEE OF MANAGEMENT

Outlining the Scope and Character of the Congress

The first active work which confronted the Committee was that of outlining the general scope and character of the Congress.

The field to be covered, the probable attendance and enrollment of members, and the number of volumes and cost of publishing the transactions were carefully considered. No previous engineering congress had been conducted along the lines which seemed to be possible and opportune for this one.

The general plan adopted can, perhaps, be best set forth by quoting from the general circular which was issued by the Committee.

PURPOSES AND SCOPE OF THE CONGRESS

Two distinct, though perhaps equally important, purposes of the Congress should be here emphasized. These are:

FIRST: The gathering together of a large and representative body of engineers from all civilized countries, with the opportunities which this will present of forming or renewing personal acquaintances, and of interchanging views on the various phases of professional work.

SECOND: The reading and discussion of papers before the various sections, and their later publication in such form as to constitute a valuable addition to any engineering library.

In scope and character, it is intended that the Congress shall be truly international, and that it shall embrace, in a thorough and comprehensive manner, the various branches of the engineering profession. Eminent engineers throughout the world will be invited to contribute papers on assigned topics, and in the selection and distribution of these topics the Committee will use its best endeavors to render the series of resulting papers widely representative of the world's best engineering practice in the various branches of the profession.

CHARACTER OF PAPERS

As a general rule, it is intended that each paper shall treat its assigned topic in a broad and comprehensive manner and with special reference to the important lines of progress during the past decade, the present most approved practices and the lines of present and future development. It is intended furthermore that all such papers shall be accompanied with a reasonably full bibliography of the subject, giving references to the important original papers and sources of information relating to the special topic of the paper. In this manner the reader will be furnished with a rapid and comprehensive review of the recent important work relating to such topic, together with references to individual papers and sources of information for more complete and minor details.

The Committee believes that papers of this type, rather than those which deal with individual constructions or special and individual problems or investigations, will generally serve better the purpose of an engineering Congress:—that papers of the latter type will naturally find their place in the proceedings of the regular sessions of the various engineering societies, while the occasion of a great engineering congress furnishes a more appropriate opportunity for papers of the broad survey or encyclopedic type.

An important exception to this general plan, however, will be found in a series of papers relating to the Panama Canal and of which it is intended to make a special feature of the Congress. These papers will deal with the engineering of the Panama Canal in all its branches, with the influence of the Canal on world commerce, commercial trade routes and general transportation problems. Colonel Goethals has promised his aid in securing this series of papers, which will thus form a definite and authoritative discussion of the engineering problems involved in this great undertaking.

In other special fields it may be found desirable to depart somewhat from the character of the papers outlined above, but in general, and aside from those relating to the Panama Canal, the papers will be of the character indicated.

In order to realize these various purposes with regard to the papers and especially to avoid either the overlapping of two or more, or the omission of some important topic, the Committee on Papers is now pre-

paring a carefully considered list of topics to be treated in the various branches of engineering, together with a general syllabus or outline of the specific ground to be covered by each paper, and to which each contributor will be asked to adhere as closely as practicable.

SECTIONS AND SESSIONS

The general field of engineering to be covered by the Congress has been divided into ten groups or branches, which, together with the special field of the Panama Canal, will constitute eleven divisions or sections, each of which will be presided over by a Chairman eminent in the branches of engineering covered by his section.

During the Congress each section will hold independent sessions, with such joint and general sessions as may be desirable or suitable having in view the subjects under consideration.

The following is a general indication of the sections and the branches of engineering which each will cover:

GENERAL SESSIONS: Official and General Addresses, Discussions on topics of general professional interest. Business Meetings, etc.

Section (1) The Panama Canal
Section (2) Waterways and Irrigation
Section (3) Municipal Engineering
Section (4) Railways
Section (5) Materials of Engineering Construction
Section (6) Mechanical Engineering
Section (7) Electrical Engineering
Section (8) Mining Engineering and Metallurgy
Section (9) Naval Architecture and Marine Engineering
Section (10) Military Engineering
Section (11) Miscellaneous

Transactions

It was originally planned that the transactions should be published in 10 volumes, with one smaller, or half, volume which would contain reports of general or business meetings, an author and title index and a brief abstract of each paper presented.

Membership Fee

The fee for membership in the Congress was fixed at $5.00, which would entitle the member to the index volume and the choice of any other one volume of the transactions, together with the right to participate in the general activities and privileges of the Congress.

Official Language

English was fixed upon as the official language of the Congress, though papers were to be received in other languages at the option of the author.

In the main, this original program was adhered to very closely. Some changes in the character and grouping of papers were necessitated by the European war, which deprived the Congress of many valuable papers which otherwise would have been received.

The magnitude of the papers on the Panama Canal and the great number of plates which accompanied them made it necessary to publish these papers in two volumes instead of one.

The great number and value of the papers secured on Metallurgy also necessitated their publication in a separate volume in addition to the volume on Mining Engineering. The actual number of volumes published, therefore, became 12 and the index, instead of 10 and the index.

Estimated Membership and Financial Considerations

The most uncertain feature which the Committee had to consider was the probable enrollment of members and sale of volumes. Here there was no precedent to serve as a guide, though it was extremely important that the probable income from membership fees and sale of volumes should be estimated with reasonable accuracy, in order to determine the resources which would be available to make the Congress as nearly as possible self-supporting.

After a careful canvass, it was thought that the enrollment of members should reach some 6000 or 8000. At the higher figure it was estimated that the total deficit to be met from the guarantee fund should not exceed from $4000 to $6000.

It is the belief of the Committee that but for the European war the larger membership and financial returns anticipated would have been fully realized.

Publicity

While the work already noted was in progress, the Committee was engaged in securing lists of engineering and technical publications and societies throughout the world to be notified of the Congress and invited to participate in its activities.

It was of course realized that the success of the Congress would be largely dependent upon its being given wide publicity. In accomplishing this, the engineering and technical press and societies in many countries rendered valuable assistance.

Announcements

On May 15, 1913, the Committee of Management issued a general circular, announcing the Congress and indicating its scope and character, to 109 domestic and 107 foreign engineering and technical publications, with the request that it be given the widest possible publicity.

The number and location of the publications addressed were as follows:

Australia	1	Italy	1
Austria	6	Mexico	1
Belgium	6	Russia	1
Canada	8	Spain	1
France	23	Switzerland	2
Germany	20	United States	109
Gt. Britain	37		

Invitations to Societies

On July 1, 1913, official invitations were issued by the five supporting societies (in the form given below) to 293 engineering and technical societies to attend and participate in the Congress.

The American Society of Civil Engineers
The American Institute of Mining Engineers
The American Society of Mechanical Engineers
The American Institute of Electrical Engineers
and
The Society of Naval Architects and Marine Engineers
extend to the officers and members of

.....

a most cordial invitation
to attend and to participate in the proceedings of
The International Engineering Congress
to be held in connection with
The Panama-Pacific International Exposition
September twentieth to twenty-fifth
in the year one thousand nine hundred and fifteen
in San Francisco
California

The geographical distribution of the societies thus invited follows:

United States of America	Hungary
Argentine Republic	India
Australia	Italy
Austria	Japan
Belgium	Mexico
Brazil	The Netherlands
Canada	New Zealand
Chile	Norway
Colombia	Peru
Cuba	Russia
Denmark	South Africa
France	Spain
Germany	Sweden
Great Britain	Switzerland

Individual Invitations

These official invitations to the societies were followed by a series of circulars addressed to the individual members of the societies.

The first circulars were issued in August, 1913. In all, 176,365 of these individual invitations were issued, of which 130,365 were sent out from the executive offices in San Francisco, 28,000 were printed in Germany and distributed by the Verein Deutsche Ingenieure, and 18,000 were printed in England and distributed by different British engineering societies.

Of the 130,365 distributed from San Francisco, 62,329 were sent to engineers in the United States and 68,036 to engineers in foreign countries. Of the latter, 37,686 were printed in English; 14,271 in French; 13,079 in German, and 3000 in Spanish.

In addition to the first circularization, follow-up circulars were from time to time sent to various societies and individuals, both in the United States and foreign countries.

Delegates and Invitations to Foreign Nations

Invitations were extended to the leading engineering and technical societies in the United States and foreign countries to be represented at the Congress by official delegates. Similar

invitations were also sent to the various technical departments of the United States Government and to foreign governments.

In the case of foreign governments it was ascertained that in most instances a favorable response to the invitation would be contingent upon the invitation being extended to them by the President of the United States through the State Department. The matter was therefore taken up with the proper officials at Washington, when it was found that the President could not issue such invitations without the authorization of Congress. Accordingly, on July 28, 1914, a joint resolution was introduced by Congressman Julius Kahn in the House and on Aug. 3, 1914, by Senator Francis G. Newlands in the Senate "Authorizing the President to extend invitations to other nations to appoint delegates or representatives to the International Engineering Congress to be held at San Francisco, California, September twentieth to twenty-fifth, inclusive, nineteen hundred and fifteen.

The Resolution was passed March 4, 1915, and in due course the official invitations were extended by the President to all foreign nations with whom diplomatic relations are maintained by the United States.

In response to these invitations delegates to the Congress were appointed by Barcelona, Spain; Canada; Cuba; China; France; Guatemala; Japan; The Netherlands; Nicaragua; Sweden; and Switzerland.*

The Honorary Officers of the Congress

As the International Engineering Congress, together with the Panama-Pacific International Exposition, was intended to celebrate the completion of the Panama Canal, it was deemed eminently appropriate that the distinguished engineer who had built this great engineering work should be asked to act as the Honorary President of the Congress. An invitation was therefore extended to Gen. Geo. W. Goethals to serve in this capacity, and which he accepted on June 12, 1913.

The selection of the Honorary Vice-Presidents of the Congress was undertaken by the Committee on Participation in New York through a sub-committee composed of Chas. Warren

* For list of delegates from technical societies, U. S. Departments and foreign nations, see p. 26, et seq.

Hunt, R. M. Thompson and Benj. W. Thayer. These vice-presidents were chosen as a representative body from among the most distinguished engineers in the various countries of the world. The list was made up in April, 1914, and invitations issued immediately. With very few exceptions, all of those invited to serve in this capacity accepted.

The Magnitude of the Work of the Committee

The Committee of Management has no desire to magnify in the slightest degree the work which was involved in the preparation for and conduct of the Congress. Each member of the Committee, and many engineers and others outside of it who were asked to aid in the work, contributed services voluntarily and without compensation for the benefit of the profession. As already noted, the Congress was the result of the united efforts of five national organizations and many individuals. It would be quite impossible even to name, much less to give proper credit to, the different individuals who aided in the work in varying degrees, and no attempt will be made to do so. It seems appropriate, nevertheless, to give to the profession some intimation of the magnitude of the work which the Congress necessitated, not only as a matter of general interest, but to serve, in some measure, as a guide to those who may be called upon to conduct a similar congress in the future.

The outlining of the scope and character of the Congress occupied a large part of the time of the members of the Committee for several months.

The selection of the topics for individual papers, the preparation of a syllabus of each, and the selection of and correspondence with possible authors naturally fell most heavily upon the Papers Committee. While this work was most exacting in 1913 and the early months of 1914, it was heavy and continuous up to the meeting of the Congress in September, and even after.

The European war threw upon the Committee much extra work which had not been anticipated, in the way of rearranging of topics and the selection of new authors to take the places of those who by reason of the war were unable to contribute the papers they had promised.

It is estimated that altogether some 750 possible authors of papers or discussions were corresponded with, of which 240 contributed papers and 127 written discussions.

The compilation of up-to-date lists of engineering and technical publications and societies, lists of individual members and subscribers, together with their constant revision, required much time and patient work and the establishment of a somewhat extensive card-index system. The general correspondence of the Committee was at times exceedingly heavy, and lastly, but not least in point of time and effort, was the work of translating papers in foreign languages and the general work of editing and revising the papers and discussions, with the large number of drawings which accompanied them, and finally the supervision of the publication of the transactions.

It would probably not be overstating the truth to estimate that the combined work performed by the different members of the Committee of Management would be the equivalent of the continuous labor of one man for a period of five years. In fact this estimate is probably under rather than over the mark, as it is estimated that three different members of the Committee during a period of four years devoted, on an average, at least one-fourth of their effective working strength to the work of the Congress.

In addition to the gratuitous work of the members of the Committee, and many others who assisted them without compensation, the work of the Congress required the employment of paid executive and clerical services as follows:

Executive Secretary	39	months
Editorial Reviser*	15	"
Draughtsman	4	"
Proof-reader	16	"
Stenographers†	84	"
Clerks	21	"

* Mr. Jno. S. Hess, Assoc. M. Am. Soc. C. E., was the editorial reviser and rendered valuable service in the technical revision and preparation for the press, of all papers, discussions, cuts and inserts.

† Miss Katherine Barkhaus served most efficiently throughout the entire life of the Committee of Management as chief stenographer and office assistant.

The European War

Immediately upon the outbreak of the European war, the Committee of Management gave careful consideration to its possible and probable effects upon the Congress. It was realized at once that even if the war proved to be of short duration, it would doubtless materially decrease the enrollment of members and hamper the preparation of papers; while if of long duration, the results to the Congress might be most serious. The propriety of abandoning or postponing the Congress was thoroughly discussed by letters and telegrams between the Committee on Participation in New York and the Committee in San Francisco. It was felt that the Committee was under obligations to the members who had already subscribed (at that time about 2000) and that if the Congress were abandoned these members would receive nothing for the money which they had contributed, and which could not be repaid, and that the preliminary work and expenditures would thus become a total loss.

After careful consideration, it was finally decided in October, 1914, that notwithstanding the difficulties and the monetary loss to the supporting societies, the Congress should proceed, each of the five societies agreeing to continue its support. The successful outcome of the Congress has abundantly justified this decision.

It is, of course, quite impossible to determine just how much loss to the Congress was caused by the war, but it was certainly very great. Though the war deprived the Congress of the full international character which it would otherwise have attained, there were, in all, 71 delegates present from foreign countries: From Europe, 19; from North and South America outside of the United States and including Cuba, 39; from India, China and Japan, 13.

Abandonment of the International Electrical Congress

Upon the outbreak of the European war the Electrical Engineers decided that it would be impracticable to hold their proposed International Congress during 1915 and the project was abandoned or postponed indefinitely.

The Committee of Management of the International Engineering Congress immediately entered into negotiations with

the Committee of the Electrical Congress, with a view to securing certain papers which were to have been presented at the Electrical Congress for presentation at the Electrical section of the general Congress and publication in its transactions, thus rounding out the treatment in the field of electrical engineering, which, by mutual agreement between the committees of the two Congresses had been originally limited to certain phases of contact between electrical engineering and other fields of engineering work. The American Institute of Electrical Engineers, however, found this inexpedient and the only direct effect of the abandonment of the Electrical Congress on the General Congress was the assumption by the Institute of enlarged participation in the underwriting of the guarantee fund and in representation on the Committee of Management, as elsewhere noted.

Society Conventions Immediately Preceding Congress

During the last days of the week immediately preceding the Congress, conventions were scheduled in San Francisco for four of the national societies supporting the Congress, viz., the American Society of Civil Engineers, the American Institute of Mining Engineers, The American Society of Mechanical Engineers and the American Institute of Electrical Engineers.

These conventions aided in drawing together in San Francisco at this time members of these various societies, practically all of whom remained over for the Congress meetings during the subsequent week.

Reception of Delegates and Foreign Members at New York and Special Railway Trip across the Country to San Francisco

Special trains from New York and New Orleans were arranged by the Joint Committee on Transportation in New York City, and were intended for the accommodation of members and delegates planning to attend the Congress and the various society meetings scheduled for the preceding week.

Foreign delegates and members of the Congress were met by members of the Committee on Participation in New York City and assisted in making the necessary arrangements to travel by the special train to San Francisco.

This trip across the country by special train afforded fine opportunities for acquaintance and the development of per-

sonal friendships among all members and delegates, both American and foreign.

THE PERSONNEL OF THE COMMITTEE OF MANAGEMENT

On March 6, 1913, when the Committee met for the purpose of organization, its constitution was as follows:

American Society of Civil Engineers

Geo. F. Swain, President
Chas. Warren Hunt, Secretary

Arthur L. Adams
W. A. Cattell
Chas. Derleth, Jr.
Chas. D. Marx

American Institute of Mining Engineers

Chas. F. Rand, President
Bradley Stoughton, Secretary

H. Foster Bain
Edw. H. Benjamin
Newton Cleaveland
Wm. S. Noyes

The American Society of Mechanical Engineers

W. F. M. Goss, President
Calvin W. Rice, Secretary

W. F. Durand
R. S. Moore
T. W. Ransom
C. R. Weymouth

American Institute of Electrical Engineers

R. D. Mershon, President
F. L. Hutchinson, Secretary

A. M. Hunt
H. A. Lardner

The Society of Naval Architects and Marine Engineers

R. M. Thompson, President
D. H. Cox, Secretary

Geo. W. Dickie
W. G. Dodd
Wm. R. Eckart
G. V. Paterson

Changes in Personnel of Committee

Various changes occurred in the personnel of the Committee during its existence due to changes in the presiding officers of the supporting societies, who were members of the Committee

by virtue of their office, and the death or resignation of the appointed members.

American Society of Civil Engineers

In January, 1914, Mr. Hunter McDonald became president of the Society, taking the place on the Committee made vacant by the retiring president, Mr. Geo. F. Swain.

Mr. Arthur L. Adams died September 17, 1913, and Mr. C. E. Grunsky was appointed in his place. In January, 1915, Mr. Chas. D. Marx became president of the Society and his place as an appointed member of the Committee was taken by Mr. Edwin Duryea, Jr.

American Institute of Mining Engineers

Succeeding Mr. Chas. F. Rand, Mr. Benj. B. Thayer became president of the Institute in 1914, and Mr. Wm. L. Saunders in 1915.

In May, 1914, Mr. E. H. Benjamin resigned and his place on the Committee was taken by Mr. R. E. Cranston. Mr. H. F. Bain resigned in February, 1915, and Mr. T. T. Read took his place as a member of the Committee.

The American Society of Mechanical Engineers

Mr. W. F. M. Goss was succeeded as president of the Society by Mr. James Hartness in 1914 and Mr. John A. Brashear in 1915.

Mr. R. S. Moore resigned in February, 1914, and was succeeded by Mr. E. C. Jones, who in turn resigned in December, 1914, and was succeeded by Mr. C. T. Hutchinson.

In December, 1914, Mr. W. F. Durand resigned as a representative of the A. S. M. E. to become a representative of the S. N. A. & M. E. in place of Mr. W. R. Eckart, deceased, and was succeeded by Mr. Thos. Morrin.

American Institute of Electrical Engineers

The term of office of the President of the A. I. E. E. expires at the mid-year. Mr. R. D. Mershon was president in 1912-13; Mr. C. O. Mailloux in 1913-14; Mr. Paul M. Lincoln in 1914-15; and Mr. J. J. Carty in 1915-16.

Mr. H. A. Lardner, who was first named as a member of the Committee, was unable to serve on account of his work on the Electrical Congress. Mr. Calvert Townley was next named,

but could not serve as he resided in New York. Mr. J. G. DeRemer was appointed March 24, 1913.

In November, 1914, Mr. J. G. DeRemer resigned and was succeeded by Mr. J. T. Whittlesey. Mr. A. M. Hunt resigned in July, 1915, and was succeeded by Mr. H. J. Ryan.

In July, 1915, after the definite abandonment of the proposed International Electrical Congress, the A. I. E. E. increased its underwriting of the expenses of the Congress from $3500 to $5000, and was thereafter represented by 6 instead of 4 members on the Committee. The additional members appointed at this time were Mr. H. A. Lardner and Mr. A. H. Babcock.

The Society of Naval Architects and Marine Engineers

Mr. Robt. M. Thompson remained president of the Society throughout the existence of the Committee of Management.

Mr. G. V. Paterson, who was first named as a member of the Committee from this Society, could not serve as he was then residing in Seattle, and Mr. H. P. Frear was appointed in his place.

Mr. W. R. Eckart died in December, 1914, and his place was taken by Mr. W. F. Durand, who had resigned as a representative of the Mechanical Engineers for that purpose.

The secretaries of the five supporting societies served without change throughout the life of the Committee.

The following members served continuously throughout the life of the Committee:

Robt. M. Thompson, Pres. S. N. A. & M. E.
Chas. Warren Hunt, Secty. Am. Soc. C. E.
Bradley Stoughton, Secty. Am. Inst. M. E.
Calvin W. Rice, Secty. Am. Soc. M. E.
F. L. Hutchinson, Secty. A. I. E. E.
Daniel H. Cox, Secty. S. N. A. & M. E.
W. F. Durand, Mem. Am. Soc. M. E. & S. N. A. & M. E.
W. A. Cattell, M. Am. Soc. C. E.
Chas. Derleth, Jr., M. Am. Soc. C. E.
Newton Cleaveland, Mem. Am. Inst. M. E.
Wm. S. Noyes, Mem. Am. Inst. M. E.
T. W. Ransom, Mem. Am. Soc. M. E.
C. R. Weymouth, Mem. Am. Soc. M. E.
Geo. W. Dickie, Mem. S. N. A. & M. E.
W. G. Dodd, Mem. S. N. A. & M. E.

Sub-Committees

On March 15, 1913, the various sub-committees of the Committee of Management were as follows:—

Participation

Geo. F. Swain
Chas. F. Rand
W. F. M. Goss
R. D. Mershon
Robt. W. Thompson
Chas. Warren Hunt
Bradley Stoughton
Calvin W. Rice
F. L. Hutchinson
Daniel H. Cox

Executive

W. F. Durand, Chairman, Ex-officio
W. A. Cattell, Secretary, Ex-officio
E. H. Benjamin
W. G. Dodd
A. M. Hunt

Finance

W. G. Dodd, Chairman
Newton Cleaveland
R. S. Moore

Papers

A. M. Hunt, Chairman
A. L. Adams
H. F. Bain
G. W. Dickie
W. R. Eckart
C. D. Marx
C. R. Weymouth

Publicity

W. A. Cattell, Chairman
C. Derleth, Jr.
W. S. Noyes
G. V. Paterson
T. W. Ransom

Local Affairs

E. H. Benjamin, Chairman
(Other members added later)

Various changes were made from time to time in the make-up of these sub-committees, in the Committee on Participation, by reason of the changes in the presidents of the Societies, and in the local sub-committees on account of the death

or resignation of members and the changing requirements of the work to be accomplished.

Messrs. Durand and Cattell served continuously throughout the life of the Committee as Chairman and Secretary-Treasurer respectively; they also served throughout as chairmen of their respective committees—Executive and Publicity.

Mr. W. G. Dodd served throughout as Chairman of the Finance Committee.

Mr. A. M. Hunt was succeeded as Chairman of the Papers Committee by Mr. G. W. Dickie.

Mr. E. H. Benjamin was succeeded as Chairman of the Local Affairs Committee by Mr. E. C. Jones, who in turn was succeeded by Mr. Thos. Morrin.

At the time of the Congress, September, 1915, the committees of the Congress were as follows:

Committee of Management

Dr. William F. Durand, Chairman
W. A. Cattell, Secretary-Treasurer

Chas. D. Marx	President	American Society of Civil Engineers
Chas. Warren Hunt	Secretary	
W. A. Cattell	Member	
C. Derleth, Jr.	Member	
Edwin Duryea, Jr.	Member	
C. E. Grunsky	Member	
W. L. Saunders	President	American Institute of Mining Engineers
Bradley Stoughton	Secretary	
Newton Cleaveland	Member	
R. E. Cranston	Member	
Wm. S. Noyes	Member	
Thos. T. Read	Member	
J. A. Brashear	President	The American Society of Mechanical Engineers
Calvin W. Rice	Secretary	
Chas. T. Hutchinson	Member	
Thos. Morrin	Member	
T. W. Ransom	Member	
C. R. Weymouth	Member	
John J. Carty	President	American Institute of Electrical Engineers
F. L. Hutchinson	Secretary	
A. H. Babcock	Member	
H. A. Lardner	Member	
H. J. Ryan	Member	
J. T. Whittlesey	Member	

Robert M. Thompson	President	The Society of Naval Architects and Marine Engineers
Daniel H. Cox	Secretary	
Geo. W. Dickie	Member	
W. G. Dodd	Member	
W. F. Durand	Member	
H. P. Frear	Member	

E. J. Dupuy, Executive Secretary

Permanent Sub-Committees

Participation

Chas. D. Marx	Chas. Warren Hunt
Wm. L. Saunders	Bradley Stoughton
J. A. Brashear	Calvin W. Rice
John J. Carty	F. L. Hutchinson
Robert M. Thompson	Daniel H. Cox

Executive

W. F. Durand, Chairman

W. A. Cattell	H. J. Ryan
R. E. Cranston	W. G. Dodd
Th. Morrin	

Finance

W. G. Dodd, Chairman	N. Cleaveland

Papers

G. W. Dickie, Chairman

Edwin Duryea, Jr.	T. T. Read
C. E. Grunsky	J. T. Whittlesey
C. R. Weymouth	

Publicity

W. A. Cattell, Chairman

C. Derleth, Jr.	W. S. Noyes
T. W. Ransom	

Local Affairs

Th. Morrin, Chairman

A. H. Babcock	C. T. Hutchinson
R. E. Cranston	H. A. Lardner
H. P. Frear	

Special Sub-Committees

Program	E. Duryea, Jr.
Reception	E. B. Bumsted
Banquet	W. W. Briggs
Excursions	A. H. Babcock
Registration	G. M. Brill
Halls and Meetings	J. S. Hess

Ladies' Entertainment

Mrs. C. E. Grunsky, Chairman

N. A. Eckart G. I. Gay

OFFICERS, DELEGATES AND MEMBERS OF THE CONGRESS

Honorary President of the Congress

Major-General George W. Goethals

Honorary Vice-Presidents

Prof. Richard Beck
Sir J. H. Biles
Otto T. Blathy
Commdr. Christian Blom
Prof. André Blondel
Dr. C. E. L. Brown
Dr. Emil A. Budde
Henry Le Chatelier
Prof. Hermann Hullmann
Prof. Luigi Luiggi
Rear Ad. Yoshihiko Mizutani
W. M. Morday
Sir Charles Parsons
Jean L. de Pulligny
V. E. Timonoff
R. P. J. Tutein-Melthenius
H. H. Vaughn
Sir Wm. Willcocks
Wm. Henry Hunter

OFFICIAL DELEGATES

United States Departments

U. S. Department of Agriculture
Prevost Hubbard, Chemical Engineer, Washington, D. C.

U. S. Department of Commerce
Capt. R. L. Faris, Asst. Supt. Coast & Geodetic Survey, Washington, D. C.

U. S. Department of the Interior
Geological Survey:
George Otis Smith, Director, 2137 Bancroft Place, Washington, D. C.
Hiram D. McCaskey, Geologist
Harry D. McGlashan, Hydraulic Engineer, U. S. Custom House, San Francisco, Calif.
George R. Davis, Geographer, Sacramento, Calif.

Bureau of Mines:
Frederick G. Cottrell, Chief Chemist, U. S. Custom House, San Francisco, Calif.
William A. Williams, Chief Petroleum Technologist
Herbert M. Wilson, Engineer

Reclamation Service:
David C. Henny, 1006 Spalding Bldg., Portland, Ore.

U. S. Treasury Department (Office of Supervising Architect)
Luther E. Jenner, Inspector, 403 P. O. Bldg., San Francisco, Calif.

U. S. War Department
Lt. Col. Thos. H. Rees, New Custom House, San Francisco

U. S. Navy Department
Rear Admiral W. L. Capps, Navy Dept., Washington, D. C.

Foreign Governments

Barcelona, Spain

Common Council of Barcelona
Dr. Ing. Ralph Campalans, 18 Ronda Universitat, Barcelona
Iltre. Sr. D. Jose de Lasarte, Prof. at "Engineers School", Barcelona

Canada

Department of the Interior
J. B. Challies, Supt. Dominion Water Power Branch, Ottawa, Canada
E. F. Drake, Supt. of Irrigation, Ottawa
F. H. Peters, Commissioner of Irrigation, Calgary

Cuba

J. R. Villalon y Sanchez, Secretary of Public Works, Havana

China

Vice-Admiral Wei-Han, Chief Naval Constructor, Peking
C. S. Chen, Ministry of Agriculture and Commerce, Peking
Chi-Yi Yen, Northwestern Council of Tientsin
K. C. Li, Hunan Mining Board
Y. C. Kuang, Ministry of Agri. and Commerce, Peking

France

Major Jean de Pulligny, Paris

Guatemala

Ing. Don Fernando Cruz, Guatemala City

Japan

Elect. Exploitation Bureau of the Ministry of Communications
S. Mayehara, Tokyo

Imperial Japanese Navy
Admiral M. Kondo, Insp.-Gen. of Naval Construction, Ministry of Marine, Tokyo

Imperial Bureau of Mines
Takeshi Hirabayashi, Geologist, Tokyo

The Netherlands

Baron W. Forstner van Dambenoy, 1120 Stanyan St., San Francisco, Calif.

Nicaragua

Señor Don Alejandro Cantón, Consul Gen'l in California, San Francisco, Calif.

Sweden

Richard Bernstrom, Comm. Gen'l to the Exposition, San Francisco, Calif.

Switzerland

Prof. Arthur Rohn, Federal Polytechnic School, Zürich

American Societies

American Association of Refrigeration, Chicago, Ill.
J. F. Nickerson, 431 So. Dearborn St., Chicago, Ill.
Will P. Stevens, Pres. Will P. Stevens Co., Los Angeles, Calif.
Theo. O. Vilter, Pres. Vilter Mfg. Co., Milwaukee, Wis.
Henry Vogt, Pres. Henry Vogt Machine Co., Louisville, Ky.
Carl Vollmann, Pres. Linde Canadian Refrig. Co., Montreal, Canada.

American Chemical Society, Washington, D. C.
Prof. C. E. Franklin, Stanford University, Calif.
Edmond O'Neill, University of California, Berkeley
Ralph A. Gould, Monadnock Bldg., San Francisco, Calif.

American Electrochemical Society, So. Bethlehem, Pa.
Lawrence Addicks, Long Branch, N. J.
F. A. Lidbury, Niagara Falls, N. Y.

The American Society of Refrigerating Engineers, New York, N. Y.
Louis K. Doelling, De La Vergne Mch. Co., New York, N. Y.
E. J. Etienne, 837 Folsom St., San Francisco, Calif.
Geo. H. Geisler, United Iron Works, Oakland, Calif.
W. H. Ross, 154 Nassau St., New York, N. Y.

American Society for Testing Materials, Philadelphia, Pa.
W. A. Doble, 19th and Harrison Sts., San Francisco, Calif.
Prof. Mansfield Merriman, New York, N. Y.
Prof. Chas. B. Wing, Leland Stanford Jr. University, Calif.

The Engineers' Club of Philadelphia
Emmett B. Carter, Midvale Steel Works, Philadelphia, Pa.

Engineers' Society of Western Pennsylvania, Pittsburgh, Pa.
A. Stucki, Oliver Bldg., Pittsburgh, Pa.
Patrick C. Noble, Pac. Rolling Mill Co., San Francisco, Calif.
Geo. C. Carson, 1201 First National Bank Bldg., San Francisco, Calif.

The Geological Society of America, New York, N. Y.
J. C. Branner, Leland Stanford Jr. University, Calif.
Andrew C. Lawson, University of California, Berkeley
C. R. Claghorn, Tacoma, Wash.

National Fire Protection Association, Boston, Mass.
John R. Freeman, 815 Grosvenor Bldg., Providence, R. I.

Railway Signal Association, Bethlehem, Pa.
Thos. S. Stevens, A. T. & S. F. Ry. System, Topeka, Kan.
W. W. Slater, Southern Pacific Co., San Francisco, Calif.

Foreign Societies

Argentina

Argentine Scientific Society, Buenos Aires
H. Anasagasti, Commissioner General of Argentina to the Panama-Pacific International Exposition, Buenos Aires

Canada

Canadian Society of Civil Engineers, Montreal
J. B. Challies, Supt. Dominion Water Power Branch, Ottawa
J. S. Dennis, Asst. to the Pres., Canadian Pacific Ry., Calgary
C. C. Worsfeld, Resident Engr. of the Public Works Dept. of British Columbia

Canadian Institute of Mining Engineers
J. D. Hurd, 6th and Rampart Sts., Los Angeles, Calif.

France

Association Général des Hygiénistes et Techniciens Municipaux, Paris
Allen Hazen, Consulting Engineer, 30 E. 42nd St., New York, N. Y.
Weston E. Fuller, Consulting Engineer, 30 E. 42nd St., New York, N. Y.

Association Internationale Du Froid, Paris
G. de Pellerin de Latouche, Paris, France

Association Française Du Froid, Paris
M. F. Lescardé, 51 Boulevard de la Chapelle, Paris

Great Britain

The Faraday Society, London
Prof. J. W. Richards, Lehigh University, So. Bethlehem, Pa.

Institute of Marine Engineers, London
J. S. Blackett, c/o Lloyd's Register of Shipping, San Francisco, Calif.

The Institution of Electrical Engineers, London
Dr. A. E. Kennelly, Harvard University, Cambridge, Mass.

The Institution of Mechanical Engineers, London
Prof. W. R. Eckart, Jr., 1445 Bryant St., Palo Alto, Calif.

The Institute of Metals, Westminster, London
Prof. Samuel L. Hoyt, Univ. of Minnesota, Minneapolis, Minn.

The Institution of Mining Engineers, London
Frederick J. Horswill, 1070 16th St., Oakland, Calif.
Robert V. Norris, 520 Second Nat'l Bank Bldg., Wilkes-Barré, Pa.

The Institution of Mining and Metallurgy, London
Dr. Frederick H. Hatch, London

The Iron and Steel Institute, London
Charles Kirchhoff, 587 Riverside Drive, New York, N. Y.

Royal Sanitary Institute, London
Geo. A. Soper, c/o Metropolitan Sewerage Comm. of New York, New York, N. Y.

Society of Engineers, Westminster, London
Harold E. Burne, c/o A. C. Evans, Avenida 5 de Mayo 32, Mexico, D. F.
C. S. Hainworth, 3a, Puerte Alvarado 54, Mexico, D. F.
B. H. M. Hewett, c/o M. M. Jacobs & Davies, 30 Church St., New York, N. Y.
P. J. McMahon, U. S. Naval Station, Key West, Fla.
J. T. Pryce-Jones, Apartado 565, Mexico, D. F.

Hungary

Kassa-Oderbergi Vasut, Budapest
Tibor Hallóssy, LL. D., Atlós út 26, Budapest
Aurel Korek, Ribáry-utca 3, Budapest
Béla Szász, Nagymezö-utca 7, Budapest
Gustavus Willheim, jun., Mexikoi-üt, 52, Budapest

Italy

Societa degli Ingegneri e Degli Architetti Italiani
Comm. J. W. Lieb, Vice-Pres., New York Edison Co., New York, N. Y.
Walter P. Rice, New York, N. Y.
Philip Torchio, New York Edison Co., New York, N. Y.
Comm. Luigi Solari
John Trautwine
Chandler Davis
Arthur H. Lawton, New York Edison Co., New York, N. Y.

Associazione Elettrotecnica Italiana
J. W. Lieb, Vice-Pres., New York Edison Co., New York, N. Y.
Philip Torchio, New York Edison Co., New York, N. Y.
Guiseppe Faccioli
Arthur H. Lawton, New York Edison Co., New York, N. Y.

Mexico

Mexican Institute of Mining Engineers, Mexico
H. L. Swain, Av. 5 de Mayo Num. 1, Mexico, D. F.

The Netherlands

Koninklijk Instituut van Ingenieurs, The Hague
H. J. E. Wenckebach, Rutger Jan Schimmelpenninck laan No. 4, The Hague

South Africa

The Chemical, Metallurgical & Mining Soc. of So. Africa, Inc., Johannesburg
Chas. Butters, 6272 Chabot Road, Oakland, Calif.
Walter Neal, Royal Basin Mining Co., Maxville, Mont.
G. M. Taylor, Portland Mill, Colorado Springs, Colo.

Spain

Institucion de Ingenieros Civiles, Madrid
Dr. Ing. Ralph Campalans, 18-Rds. Universitat, Barcelona
Iltre. Sr. D. Jose de Lasarte, Prof. at Engineers School, Barcelona

Sweden

Svenska Teknologforeningen, Stockholm
Julius Körner, c/o Swedish General Electric Co., Vasteras

Switzerland

Schweizerischer Ingenieur- und Architekten-Verein, Zürich
Ing. A. Rohn, Prof., Eidgenössischen technischen Hochschule in Zürich

LIST OF MEMBERS AND DELEGATES WHO REGISTERED DURING THE SESSIONS OF THE CONGRESS

United States and Possessions

Abbey, Frank H. Boston, Mass.
Abel, A. H. Portland, Ore.
Addicks, Lawrence Long Branch, N. J.
Aertsen, Guilliaem Philadelphia, Pa.
Affolter, P. H. San Francisco, Calif.
Alden, L. T. San Francisco, Calif.
Allan, Thomas J. Oakland, Calif.
Allin, T. D. Pasadena, Calif.
Allison, J. C. Calexico, Calif.
Allison, Wm. F. Seattle, Wash.
Alvarez, Arthur C. Berkeley, Calif.
Alverson, C. S. San Diego, Calif.
Amidon, R. G. Cornucopia, Ore.
Anderson, Geo. G. Los Angeles, Calif.
Angwin, Henry R. Oakland, Calif.
Armes, Geo. A. San Francisco, Calif.
Armitage, Geo. W. Oahu, T. H.
Ash, Dorsey San Francisco, Calif.
Ashton, Raymond San Francisco, Calif.
Austin, W. L. Riverside, Calif.

Babcock, A. H. San Francisco, Calif.
Babcock, Wm. Stuart New York, N. Y.

Bacon, H. M. San Francisco, Calif.
Bazeley, Arthur J. Cleveland, Ohio
Bailhache, John G. San Francisco, Calif.
Baird, Dudley San Francisco, Calif.
Baker, A. R. San Rafael, Calif.
Baker, Chas. Whiting New York, N. Y.
Baker, Shirley San Francisco, Calif.
Baltasar, Apolinani Manila, P. I.
Barnard, W. K. Los Angeles, Calif.
Barnes, Jr., H. H. New York, N. Y.
Barry, Jas. M. San Francisco, Calif.
Bates, F. J. Alameda, Calif.
Battelle, Geo. I. San Francisco, Calif.
Baum, Frank G. San Francisco, Calif.
Bausch, F. E. St. Louis, Mo.
Baxter, F. E. Berkeley, Calif.
Bayley, Edgar A. Los Angeles, Calif.
Bayley, Guy L. San Francisco, Calif.
Bean, K. C. Bremerton, Wash.
Bebb, J. C. San Francisco, Calif.
Beckman, J. W. San Francisco, Calif.
Beebee, Ralph A. San Francisco, Calif.
Beecher, Henry Ward Seattle, Wash.
Belknap, Wm. E. New York, N. Y.
Bell, Arthur F. L. San Francisco, Calif.
Benedict, W. de L. New York, N. Y.
Benjamin, Edw. H. Oakland, Calif.
Bergquist, J. G. Glen Head, L. I., N. Y.
Bernegan, Carl M. Hoboken, N. J.
Best, Wm. N. New York, N. Y.
Bienenfeld, Abel M. San Francisco, Calif.
Bienenfeld, Bernard San Francisco, Calif.
Binkley, Geo. H. Oakland, Calif.
Bissell, Geo. W. East Lansing, Mich.
Bivins, W. T. San Francisco, Calif.
Bixby, Frederick L. State College, N. M.
Blackett, J. S. San Francisco, Calif.
Blake, S. H. Schenectady, N. Y.
Blood, Geo. D. Salt Lake City, Utah
Boggs, Edward M. Oakland, Calif.
Borough, E. W. San Francisco, Calif.
Boutwell, John M. Santa Barbara, Calif.
Bovyer, Wm. B. San Francisco, Calif.
Bowers, Nathan A. San Francisco, Calif.
Bowes, Laurence C. Chicago, Ill.
Bowie, Jr., Aug. J. San Francisco, Calif.
Bowie, C. P. San Francisco, Calif.

Brackenridge, W. A. Los Angeles, Calif.
Bradford, P. L. Placentia, Calif.
Bradley, F. W. San Francisco, Calif.
Bradley, P. R. Treadwell, Alaska
Bragg, Geo. H. San Francisco, Calif.
Brashear, John A. Pittsburgh, Pa.
Braun, C. F. San Francisco, Calif.
Brayton, Corey C. San Francisco, Calif.
Brett, Henry E. Los Angeles, Calif.
Briggs, W. W. San Francisco, Calif.
Brill, Geo. M. Berkeley, Calif.
Bristol, Wm. H. Waterbury, Conn.
Brown, A. A. Oakland, Calif.
Brown, Bedford J. Charlotte, N. C.
Brown, J. Maughs Vermillion, S. D.
Brown, LeGrand San Francisco, Calif.
Brown, Perry F. Oakland, Calif.
Brown, U. G. San Francisco, Calif.
Brownell, John R. San Francisco, Calif.
Brua, Elmer G. San Francisco, Calif.
Brunnier, Henry J. San Francisco, Calif.
Budd, Ralph St. Paul, Minn.
Bumsted, E. Bradford San Francisco, Calif.
Burkett, C. W. San Francisco, Calif.
Burlingame, Luther D. Providence, R. I.
Burnet, Edgar E. San Francisco, Calif.
Burnett, C. E. Escalon, Calif.
Burnham, G. B. Reno, Nev.
Burrage, J. Otis San Francisco, Calif.
Bush, Philip L. San Francisco, Calif.
Butters, Chas. Oakland, Calif.
Byers, A. M. C. San Francisco, Calif.
Byers, C. H. San Francisco, Calif.

Caldwell, F. B. San Francisco, Calif.
Campbell, Henry A. San Francisco, Calif.
Campion, Geo. B. New York, N. Y.
Capps, Washington L. Washington, D. C.
Carnahan, Jr., R. B. Middletown, Ohio
Carpenter, E. E. Forest Ranch, Calif.
Carpenter, J. C. San Francisco, Calif.
Carrigan, Andrew San Francisco, Calif.
Carson, Geo. C. San Francisco, Calif.
Carter, Emmett B. Philadelphia, Pa.
Carter, W. D. San Jose, Calif.
Carty, J. J. New York, N. Y.
Case, Benjamin H. Asheville, N. C.

Cattell, W. A. San Francisco, Calif.
Cheever, Markham Salt Lake City, Utah
Chidester, W. B. Keswick, Calif.
Child, Stephen San Francisco, Calif.
Christie, A. G. Baltimore, Md.
Church, Hartley R. Berkeley, Calif.
Churchill, Chas. S. Roanoke, Va.
Clapp, W. A. Oakland, Calif.
Clark, Herbert H. Los Angeles, Calif.
Clark, Howard F. San Francisco, Calif.
Clark, W. Lea Jerome, Ariz.
Clarke, David D. Portland, Ore.
Claussen, T. H. Sausalito, Calif.
Cleaveland, Newton San Francisco, Calif.
Clevenger, G. H. Palo Alto, Calif.
Clifford, Reginald G. Sacramento, Calif.
Cobleigh, H. R. Brooklyn, N. Y.
Coe, Ira J. Oakland, Calif.
Colby, S. K. New York, N. Y.
Cole, Chas. S. San Francisco, Calif.
Cole, Daniel W. Fallon, Nev.
Condit, C. E. Portland, Ore.
Cone, D. I. Berkeley, Calif.
Connick, Harris D. H. San Francisco, Calif.
Connor, Edward H. Leavenworth, Kan.
Cook, Edgar W. Los Angeles, Calif.
Cooper, F. F. San Francisco, Calif.
Cope, Erle L. San Francisco, Calif.
Cory, C. L. Berkeley, Calif.
Cory, Harry T. San Francisco, Calif.
Cottrell, F. G. San Francisco, Calif.
Couchot, Maurice C. San Francisco, Calif.
Cox, Augustus D. Grass Valley, Calif.
Cox, Thos. Oakland, Calif.
Cranston, Robert E. San Francisco, Calif.
Crawford, Perry O. Palo Alto, Calif.
Crocker, Herbert S. Denver, Colo.
Crooks, C. H. New York, N. Y.
Crosby, Walter W. Baltimore, Md.
Cross, Chas. N. Palo Alto, Calif.
Cunningham, G. H. Anaconda, Mont.

Daae, H. A. Sacramento, Calif.
Darrow, W. J. New York, N. Y.
Dater, Philip H. Portland, Ore.
Davidson, J. B. Davis, Calif.
Davis, E. R. Los Angeles, Calif.

Davis, Frederick Davenport, Calif.
Davis, F. H. San Francisco, Calif.
Davis, Geo. R. Sacramento, Calif.
Davis, Geo. W. San Francisco, Calif.
Davis, Jr., W. J. San Francisco, Calif.
Day, David T. Washington, D. C.
Day, Richard F. Germantown, Pa.
Dearborn, R. H. Corvallis, Ore.
Delany, Chas. H. San Francisco, Calif.
Dennis, Clifford G. San Francisco, Calif.
Dennis, H. W. Los Angeles, Calif.
Denny, Omer San Francisco, Calif.
Derleth, Jr., Chas. Berkeley, Calif.
Dewell, H. D. San Francisco, Calif.
Deyo, S. L. F. New York, N. Y.
D'Heur, Allard San Francisco, Calif.
Diamant, N. S. Houston, Tex.
Dibble, Barry Minidoka, Ida.
Dibert, H. M. Troy, N. Y.
Dick, J. C. Salt Lake City, Utah
Dickie, G. W. San Francisco, Calif.
Diericx, A. C. Los Altos, Calif.
Dillman, Geo. L. San Francisco, Calif.
Dimock, Arthur H. Seattle, Wash.
Doble, W. A. San Francisco, Calif.
Dockweiler, J. H. San Francisco, Calif.
Dodd, W. G. San Francisco, Calif.
Doelling, Louis K. New York, N. Y.
Dorward, Jr., D. San Francisco, Calif.
Duncan, Lindsay McGill, Nev.
Dunn, Berry E. San Francisco, Calif.
Dunn, Gano New York, N. Y.
Dunn, P. Livingston San Francisco, Calif.
Dupuy, E. J. San Francisco, Calif.
Durand, W. F. Stanford University, Calif.
DuRell, C. Terry Los Angeles, Calif.
Durham, Edward B. Berkeley, Calif.
Durham, Henry Welles New York, N. Y.
Duryea, Jr., Edwin San Francisco, Calif.
Duryea, Robert F. San Francisco, Calif.
Duschak, L. H. Berkeley, Calif.
Dutton, Chas. E. Goldfield, Nev.
Dygert, H. I. Berkeley, Calif.

Easton, R. D. Sacramento, Calif.
Easton, Stanley A. Kellogg, Ida.
Eastwood, John S. San Francisco, Calif.

Eaton, Burdick Los Angeles, Calif.
Eaton, E. C. San Francisco, Calif.
Eaton, Fred Big Pine, Calif.
Eaton, G. M. Pittsburgh, Pa.
Eavenson, H. N. Gary, W. Va.
Eckart, N. A. San Francisco, Calif.
Eckart, Jr., W. R. Palo Alto, Calif.
Eddy, A. J. Berkeley, Calif.
Edwards, H. R. San Francisco, Calif.
Egbert, Warren San Francisco, Calif.
Eilers, Karl New York, N. Y.
Elliott, Arthur H. New York, N. Y.
Elliott, G. R. San Francisco, Calif.
Ellis, G. E. Washington, D. C.
Enderwies, G. T. Los Angeles, Calif.
Enger, A. L. Tucson, Ariz.
Etcheverry, Bernard A. Berkeley, Calif.
Eustis, T. W. Hinsdale, Ill.
Everett, E. E. Ventura, Calif.

Faris, R. L. Washington, D. C.
Fenley, W. H. Chicago, Ill.
Ferris, Livingston P. New York, N. Y.
Finkle, F. C. Los Angeles, Calif.
Finney, John H. Washington, D. C.
Fish, John C. L. Palo Alto, Calif.
Fisken, J. B. Spokane, Wash.
Fitting, J. W. San Francisco, Calif.
FitzGerald, Gerald C. Los Angeles, Calif.
Flaa, Ingwald E. San Francisco, Calif.
Flagg, A. L. Kelvin, Ariz.
Fogg, Wm. W. Oakland, Calif.
Folsom, Eugene L. Waltham, Mass.
Foote, Arthur B. Grass Valley, Calif.
Foote, Arthur de W. Grass Valley, Calif.
Foote, Jr., Francis S. Berkeley, Calif.
Ford, D. E. San Francisco, Calif.
Ford, F. E. San Francisco, Calif.
Forrest, Chas. N. Maurer, N. J.
Forstner, Wm. San Francisco, Calif.
Foucar, E. L. San Francisco, Calif.
Fraser, Guy O. Grafton, Calif.
Frear, Hugo P. San Francisco, Calif.
Freeman, John R. Providence, R. I.
Frickstad, Walter N. Oakland, Calif.
Frisell, E. H. San Francisco, Calif.
Fulcher, Ray Oakland, Calif.

Fuller, Almon H. Seattle, Wash.
Fuller, Geo. W. New York, N. Y.

Galloway, John D. Berkeley, Calif.
Garrison, F. Lynwood Philadelphia, Pa.
Gartley, Alonzo Honolulu, T. H.
Gates, Philetus W. Chicago, Ill.
Gay, F. W. San Francisco, Calif.
Gay, G. I. Berkeley, Calif.
Gaylord, J. C. So. Pasadena, Calif.
Gebhardt, C. W. San Francisco, Calif.
Geisler, Geo. H. Oakland, Calif.
Gerry, Jr., M. H. Helena, Mont.
Gester, Wm. B. San Francisco, Calif.
Gibson, A. San Francisco, Calif.
Giddings, Frederick Lake Charles, La.
Gideon, Abraham Manila, P. I.
Givan, Albert Sacramento, Calif.
Gleason, Kate Rochester, N. Y.
Goethals, George W. Balboa Heights, C. Z.
Goldingham, Arthur H. New York, N. Y.
Goldman, Oscar Berkeley, Calif.
Goldschmidt, A. L. Helena, Mont.
Goodale, Chas. W. Butte, Mont.
Graf, S. H. Corvallis, Ore.
Graff, B. H. San Francisco, Calif.
Grant, Kenneth C. Dayton, Ohio
Grant, Lester S. Stent, Calif.
Graton, L. C. Cambridge, Mass.
Gray, Harold F. Palo Alto, Calif.
Gray, R. W. San Francisco, Calif.
Green, Frederick M. Berkeley, Calif.
Green, H. E. Los Angeles, Calif.
Greer, Jas. A. New York, N. Y.
Griffin, Augustus Manteca, Calif.
Grimm, Paul H. Glen Cove, L. I., N. Y.
Griswold, A. H. San Francisco, Calif.
Griswold, Horace S. Berkeley, Calif.
Griswold, Lee S. San Francisco, Calif.
Grunsky, C. E. San Francisco, Calif.
Grunwald, Kurt Denver, Colo.
Guitéras, H. G. Bingham Canyon, Utah
Guitéras, J. G. Bingham Canyon, Utah
Gunn, Chas. M. San Francisco, Calif.

Haar, Selby New York, N. Y.
Haas, Edward F. San Francisco, Calif.

Haehl, Harry L. San Francisco, Calif.
Hall, H. H. San Francisco, Calif.
Hall, H. Y. San Francisco, Calif.
Halloran, A. H. San Francisco, Calif.
Halsey, Milo C. So. Pasadena, Calif.
Ham, P. M. San Francisco, Calif.
Hamilton, E. H. Port Norfolk, Va.
Hammatt, Wm. C. San Francisco, Calif.
Hanique, Jules E. Oakland, Calif.
Hanks, Abbot A. San Francisco, Calif.
Hanscom, W. W. San Francisco, Calif.
Harding, S. T. Berkeley, Calif.
Hardison, Allen C. Santa Paula, Calif.
Harley, E. B. Woodland, Calif.
Harmon, Jr., A. K. P. San Francisco, Calif.
Harper, J. B. Stoddard, Ariz.
Harris, Albert L. San Francisco, Calif.
Harris, Frank S. M. Oakland, Calif.
Harroun, P. E. San Francisco, Calif.
Hartness, James Springfield, Vt.
Haskell, Eugene E. Ithaca, N. Y.
Hawgood, Harry Los Angeles, Calif.
Hawkins, Geo. W. Tucson, Ariz.
Hawley, John B. Fort Worth, Tex.
Hawley, R. S. Emeryville, Calif.
Hawley, R. W. San Francisco, Calif.
Hays, John Coffee San Francisco, Calif.
Hazen, Allen New York, N. Y.
Hedges, Geo. L. Los Angeles, Calif.
Hedges, Samuel H. Seattle, Wash.
Henderson, Herman B. Berkeley, Calif.
Henderson, J. R. Denver, Colo.
Hendrickson, Wm. H. Frisco, Utah
Henes, Louis G. San Francisco, Calif.
Hepburn, H. M. San Francisco, Calif.
Herbert, E. H. Oakland, Calif.
Herrmann, Frederick C. San Francisco, Calif.
Herron, G. M. Palo Alto, Calif.
Hess, F. M. Bishop, Calif.
Hess, Jno. S. San Francisco, Calif.
Hewett, John R. Schenectady, N. Y.
Heymann, Bruno San Francisco, Calif.
Hillebrand, W. A. San Francisco, Calif.
Himes, Edw. J. Dallas, Ore.
Hindes, S. G. San Francisco, Calif.
Hjul, James H. San Francisco, Calif.
Hohl, L. J. Berkeley, Calif.

Hohl, Leonard L. Sausalito, Calif.
Holcomb, Chas. H. San Francisco, Calif.
Holly, Jesse B. San Francisco, Calif.
Hollzer, Marc Berkeley, Calif.
Holt, C. Parker Stockton, Calif.
Hood, John San Francisco, Calif.
Hood, Wm. San Francisco, Calif.
Hopkins, C. Harold Los Angeles, Calif.
Horton, Roy S. Santa Ana, Calif.
Howard, Henry S. San Francisco, Calif.
Howe, J. M. Houston, Tex.
Hsia, C. S. Berkeley, Calif.
Hubbard, Prevost Washington, D. C.
Huber, W. L. San Francisco, Calif.
Hudson, Robert A. San Francisco, Calif.
Hunt, Chas. Warren New York, N. Y.
Hunt, Eugene Los Angeles, Calif.
Hunt, Loren E. San Francisco, Calif.
Hunter, Thos. B. San Francisco, Calif.
Hurd, J. D. Chicago, Ill.
Hurlbut, H. S. G. Mono Lake, Calif.
Hurlbut, Wm. W. Los Angeles, Calif.
Hurst, Geo. L. San Francisco, Calif.
Hutchinson, Chas. T. San Francisco, Calif.
Hutchinson, Ely C. San Francisco, Calif.
Hutchinson, F. L. New York, N. Y.
Hyde, Chas. Gilman Berkeley, Calif.

Innes, Murray Cambria, Calif.

Jacobs, J. L. Houston, Tex.
Jaedicke, Fritz New York, N. Y.
Janin, Chas. San Francisco, Calif.
Jenks, Arthur W. Berkeley, Calif.
Jenner, Luther E. San Francisco, Calif.
Jennings, Hennen Washington, D. C.
Jennings, Sidney J. New York, N. Y.
Johnson, F. M. San Francisco, Calif.
Johnson, Paul F. Milwaukee, Wis.
Jollyman, J. P. San Francisco, Calif.
Jones, Edward C. San Francisco, Calif.
Jones, E. P. San Francisco, Calif.
Jones, G. Douglas Sacramento, Calif.
Jones, Leon B. San Francisco, Calif.
Jubb, Sherman A. Los Angeles, Calif.
Judell, Adolph San Francisco, Calif.

Kempkey, A. San Francisco, Calif.
Kennedy, H. J. San Francisco, Calif.

Kennedy, J. E. Flagstaff, Ariz.
Kent, P. J. Clinton, Mo.
Kephart, C. I. San Francisco, Calif.
Kerns, F. W. San Francisco, Calif.
Kerr, Mark B. San Francisco, Calif.
Kibbe, A. S. Berkeley, Calif.
King, F. S. New York, N. Y.
Kinkead, J. A. New York, N. Y.
Kitts, J. A. Grass Valley, Calif.
Kline, G. R. San Francisco, Calif.
Knopp, Otto A. Oakland, Calif.
Knox, S. L. G. San Francisco, Calif.
Koontz, Jr., John A. San Francisco, Calif.
Kriegsman, Eugene F. San Francisco, Calif.
Kromer, C. H. Sacramento, Calif.
Kunz, Geo. F. New York, N. Y.

Lane, J. Harold San Francisco, Calif.
Langille, H. B. Berkeley, Calif.
Lardner, Henry A. San Francisco, Calif.
Lasher, Ramsdell S. Evanston, Ill.
Latham, Marcus L. Melones, Calif.
Lavagnino, G. Pasadena, Calif.
Lawson, Andrew C. Berkeley, Calif.
Lawton, A. H. New York, N. Y.
Lebedeff, M. N. Denver, Colo.
Lebenbaum, Paul Portland, Ore.
Le Conte, Jos. N. Berkeley, Calif.
Lee, Carl Nokomis, Ill.
Lee, Chas. H. Los Angeles, Calif.
Lee, Wah S. Stanford University, Calif.
Legaré, B. P. San Francisco, Calif.
Leonard, Henry R. Philadelphia, Pa.
Lesley, E. P. Stanford University, Calif.
Lewis, C. G. San Francisco, Calif.
Lietz, Adolph San Francisco, Calif.
Lindemann, W. C. Milwaukee, Wis.
Lisberger, S. J. San Francisco, Calif.
Lissau, O. F. Schenectady, N. Y.
Lloyd, M. G. Chicago, Ill.
Lohman, R. W. Los Altos, Calif.
Lombardi, M. E. Berkeley, Calif.
Lopez, Joseph V. San Pedro, Calif.
Loweth, Chas. F. Chicago, Ill.
Ludlow, Edwin Lansford, Pa.
Lukes, J. B. San Francisco, Calif.
Lundgren, Leonard Portland, Ore.

Lyman, Richard R. Salt Lake City, Utah
Lynn, W. A. Vallejo, Calif.
Lyon, D. A. Salt Lake City, Utah

MacGregor, R. A. New York, N. Y.
McClure, David San Francisco, Calif.
McCoy, Jos. M. Berkeley, Calif.
McCoy, Louis E. Juneau, Alaska
McCoy, W. E. New York, N. Y.
McCurdy, R. G. Berkeley, Calif.
McGlashan, H. D. Berkeley, Calif.
McGonigle, Chas. Portland, Ore.
McGregor, G. San Francisco, Calif.
McKay, Geo. A. Mare Island, Calif.
McKay, M. C. San Francisco, Calif.
McKinney, V. W. Palo Alto, Calif.
McLain, Louis R. St. Augustine, Fla.
McLaughlin, A. C. San Francisco, Calif.
McMeekin, Chas. W. San Francisco, Calif.
McMillan, J. G. San Jose, Calif.
McMillan, W. Bruce San Jose, Calif.
Madison, J. T. San Francisco, Calif.
Manley, Rowland Chicago, Ill.
Manson, Marsden San Francisco, Calif.
Markwart, A. H. Oakland, Calif.
Martin, C. R. San Francisco, Calif.
Martin, F. Oskar San Francisco, Calif.
Martin, James W. Long Beach, Calif.
Martindale, E. H. Cleveland, Ohio
Martindale, R. W. San Francisco, Calif.
Marx, Chas. D. Palo Alto, Calif.
Marx, Guido H. Stanford University, Calif.
Mason, R. T. Los Angeles, Calif.
Matson, John J. Palo Alto, Calif.
Mead, Elwood Berkeley, Calif.
Means, Thos. H. San Francisco, Calif.
Mehren, E. J. New York, N. Y.
Mel, W. Bartlett Berkeley, Calif.
Mellin, C. J. Schenectady, N. Y.
Menefoglio, A. Kauai, T. H.
Mercado, L. R. San Francisco, Calif.
Meredith, Wynn San Francisco, Calif.
Merrill, Chas. W. San Francisco, Calif.
Merriman, Mansfield New York, N. Y.
Metcalf, Leonard Boston, Mass.
Metcalfe, G. W. Kennett, Calif.
Mini, Jr., Jos. San Francisco, Calif.

Mitke, Chas. A. Bisbee, Ariz.
Modjeski, Ralph New York, N. Y.
Moen, Leclanché New York, N. Y.
Monges, R. F. Portland, Ore.
Monroe, R. A. San Francisco, Calif.
Moran, Robert B. San Francisco, Calif.
Morley, W. S. Berkeley, Calif.
Morrin, Thos. San Francisco, Calif.
Morris, F. L. San Francisco, Calif.
Morris, S. B. Pasadena, Calif.
Moulthrop, B. L. San Francisco, Calif.
Mower, H. C. Tuscaloosa, Ala.
Mudd, S. W. Los Angeles, Calif.
Muhs, Frederick R. San Francisco, Calif.
Murphy, Fred E. W. New Brighton, N. Y.
Myers, Romaine W. Oakland, Calif.

Nagle, J. C. Austin, Tex.
Naphtaly, Sam L. San Francisco, Calif.
Nauman, F. D. New York, N. Y.
Neal, Walter Maxville, Mont.
Newbury, F. D. Pittsburgh, Pa.
Newman, E. Los Angeles, Calif.
Newman, G. O. Los Angeles, Calif.
Newman, Jerome San Francisco, Calif.
Nickerson, Geo. S. Sacramento, Calif.
Nickerson, J. F. Chicago, Ill.
Nishkian, Leon H. San Francisco, Calif.
Noack, H. R. San Francisco, Calif.
Noble, H. A. Berkeley, Calif.
Nolte, Robt. W. New Orleans, La.
Norris, R. V. Wilkes-Barré, Pa.
Noyes, Wm. S. San Francisco, Calif.

O'Brien, J. D. Pioneer, Nev.
O'Brien, T. H. Dawson, N. M.
O'Hara, F. J. San Francisco, Calif
O'Shaughnessy, M. M. San Francisco, Calif.
Oakley, Frank T. Oakland, Calif.
Oatman, F. W. Sacramento, Calif.
Oliver, Edwin L. San Francisco, Calif.
Oliver, Emery Sacramento, Calif.
Olsen, Tinius Philadelphia, Pa.
Ost, Paul J. San Francisco, Calif.
Overocker, D. W. Troy, N. Y.
Owens, James M. San Francisco, Calif.

Palmer, H. K. Los Angeles, Calif.
Pardee, Jas. T. Cleveland, Ohio

Parmelee, H. C. Denver, Colo.
Parsons, A. T. San Francisco, Calif.
Parsons, Maurice G. Pasadena, Calif.
Partridge, John F. San Francisco, Calif.
Paul, Earl W. Upland, Calif.
Paulsmeier, Albert C. San Francisco, Calif.
Pearl, Walter Los Angeles, Calif.
Peck, M. H. Berkeley, Calif.
Peek, Jr., F. W. Schenectady, N. Y.
Pegram, Geo. H. New York, N. Y.
Penniman, L. E. San Francisco, Calif.
Peters, J. F. San Francisco, Calif.
Peterson, A. M. Erie, Pa.
Pfund, Richard New York, N. Y.
Phelps, Wm. H. San Francisco, Calif.
Phillips, Wm. B. Golden, Colo.
Pierce, A. L. Wallingford, Conn.
Pioda, A. W. Redwood City, Calif.
Pitman, S. M. Providence, R. I.
Polakov, Walter N. New Haven, Conn.
Poon, Fong Kim San Francisco, Calif.
Pope, J. B. San Francisco, Calif.
Popert, William H. San Francisco, Calif.
Posey, Geo. A. Piedmont, Calif.
Poss, Victor H. San Francisco, Calif.
Pracy, Geo. W. San Francisco, Calif.
Pratt, Robt. J. Honolulu, T. H.
Pratt, Wallace E. Manila, P. I.
Prell, John S. San Francisco, Calif.
Probert, Frank H. Berkeley, Calif.
Putnam, B. R. Berkeley, Calif.

Rand, Chas. F. New York, N. Y.
Randall, H. I. Berkeley, Calif.
Ransom, T. W. San Francisco, Calif.
Rawlings, Stuart L. Oakland, Calif.
Ray, James C. Palo Alto, Calif.
Reaburn, D. L. Ashford, Wash.
Read, Thos. T. Redding, Calif.
Redfield, C. M. Deschutes, Ore.
Reed, Ralph J. Los Angeles, Calif.
Reinhardt, H. Berkeley, Calif.
Reist, H. G. Schenectady, N. Y.
Rhodes, C. I. Berkeley, Calif.
Rhodes, G. V. San Francisco, Calif.
Rhodin, Carl J. San Francisco, Calif.
Rice, Calvin W. New York, N. Y.

Rice, Geo. S. Pittsburgh, Pa.
Richards, J. W. So. Bethlehem, Pa.
Richardson, Clifford New York, N. Y.
Richardson, W. V. Oakland, Calif.
Rickard, T. A. San Francisco, Calif.
Ricketts, L. D. New York, N. Y.
Riffle, Franklin San Francisco, Calif.
Robb, Geo. C. San Francisco, Calif.
Roberts, J. C. Denver, Colo.
Roberts, Milnor Seattle, Wash.
Robinson, L. T. Schenectady, N. Y.
Robson, F. T. Berkeley, Calif.
Robson, R. E. Atascadero, Calif.
Rodegerdts, Chris. A. San Francisco, Calif.
Rodgers, M. K. Sawtelle, Calif.
Rogers, Edwin A. San Francisco, Calif.
Rollow, J. Grady Long Beach, Calif.
Rommel, Wm. C. Philadelphia, Pa.
Rosen, C. G. A. San Francisco, Calif.
Rosenthal, J. J. San Francisco, Calif.
Ross, W. H. New York, N. Y.
Rouse, H. M. Calexico, Calif.
Rowley, R. L. San Francisco, Calif.
Rushmore, David B. Schenectady, N. Y.
Ryan, Harris J. Stanford University, Calif.
Ryan, Walter J. Snoqualmie, Wash.

Sanders, William H. Los Angeles, Calif.
Sandner, Adolph C. A. Berkeley, Calif.
Saunders, Henry J. San Francisco, Calif.
Saunders, William L. New York, N. Y.
Scarfe, George Nevada City, Calif.
Schindler, A. D. San Francisco, Calif.
Schlachter, Carl H. Passaic, N. J.
Schneider, Edward J. San Francisco, Calif.
Schorch, Max Brooklyn, N. Y.
Schorr, Robert San Francisco, Calif.
Schuchardt, R. F. Chicago, Ill.
Schwendener, Karl D. Los Angeles, Calif.
Scrugham, J. G. Reno, Nev.
Scupham, Herbert S. Cazadero, Ore.
Scaright, F. Harvey San Francisco, Calif.
Seaver, Walter H. San Francisco, Calif.
Setz, H. R. St. Louis, Mo.
Seymour, J. A. Auburn, N. Y.
Shane, B. D. Juneau, Alaska
Shaw, Sidney B. San Francisco, Calif.

Sherman, Gerald Bisbee, Ariz.
Shimer, H. W. San Francisco, Calif.
Shockley, W. H. Palo Alto, Calif.
Shreve, E. O. San Francisco, Calif.
Shutts, F. O. San Francisco, Calif.
Simonds, Ernest H. San Francisco, Calif.
Simonson, G. M. Sacramento, Calif.
Smith, A. Parker New York, N. Y.
Smith, Frank E. San Francisco, Calif.
Smith, Frank M. E. Helena, Mont.
Smith, G. E. P. Tucson, Ariz.
Smith, Geo. Otis Washington, D. C.
Smith, Jesse M. New York, N. Y.
Smith, Walter V. San Francisco, Calif.
Smith, W. W. Los Angeles, Calif.
Smyth, Wm. H. San Francisco, Calif.
Snyder, Christopher H. San Francisco, Calif.
Sperr, F. W. Houghton, Mich.
Sperry, Austin San Francisco, Calif.
Stalder, Walter San Francisco, Calif.
Stanton, W. P. San Francisco, Calif.
Starr, R. C. Los Angeles, Calif.
Stava, Wm. San Francisco, Calif.
Stearns, Ralph H. Boston, Mass.
Stebbins, H. W. Palo Alto, Calif.
Steele, I. C. San Francisco, Calif.
Stevenot, J. E. Manila, P. I.
Stevens, J. Franklin Philadelphia, Pa.
St. John, R. U. San Francisco, Calif.
Stocker, Leslie W. San Francisco, Calif.
Stoughton, Bradley New York, N. Y.
Strout, Gale S. San Francisco, Calif.
Stucki, Arnold Pittsburgh, Pa.
Sullivan, Geo. L. Santa Clara, Calif.
Sultan, Walter D. San Francisco, Calif.
Summerhayes, H. R. Schenectady, N. Y.
Swain, Geo. F. Boston, Mass.
Swasey, Ambrose Cleveland, Ohio

Tappan, Roger Topsfield, Mass.
Taylor, G. M. Colorado Springs, Colo.
Taylor, James T. Honolulu, T. H.
Teeter, E. E. Las Cruces, N. M.
Terwilliger, Harry L. San Francisco, Calif.
Thayer, Ignatius E. San Francisco, Calif.
Thom, Jr., Neil Piedmont, Calif.
Thomas, Carl C. Baltimore, Md.

Thomas, P. H. New York, N. Y.
Thompson, Benjamin Tampa, Fla.
Thompson, Laurence San Francisco, Calif.
Thompson, Robert M. Washington, D. C.
Thomson, Herbert G. Dedrick, Calif.
Thunen, Geo. W. Berkeley, Calif.
Thurston, E. T. San Francisco, Calif.
Tibbetts, Fred H. San Francisco, Calif.
Tillinghast, F. H. Fallon, Nev.
Todd, Oliver J. Groveland, Calif.
Townsend, C. McD. St. Louis, Mo.
Trask, Frank E. Los Angeles, Calif.
Trowbridge, Alfred L. San Francisco, Calif.
Tschentscher, R. Chicago, Ill.
Tubby, W. G. San Francisco, Calif.
Turner, C. E. Boston, Mass.
Turner, Henry W. San Francisco, Calif.
Turner, J. K. Goldfield, Nev.
Tyler, R. G. Paris, Tex.

Upp, John W. Schenectady, N. Y.
Upton, William B. San Francisco, Calif.

Vail, David P. San Francisco, Calif.
Van Vleck, Frank San Francisco, Calif.
Van Norden, Rudolph San Francisco, Calif.
Veatch, J. Allen Napa, Calif.
Vensano, Harry C. San Francisco, Calif.
Vilter, Theo. O. Milwaukee, Wis.
Vincent, Jr., W. G. San Francisco, Calif.

Wade, B. F. San Francisco, Calif.
Wadsworth, Henry H. San Francisco, Calif.
Wagner, Herman A. East Orange, N. J.
Wagoner, Luther San Francisco, Calif.
Wallace, J. H. San Francisco, Calif.
Walton, S. V. San Francisco, Calif.
Waltman, W. Casper, Wyo.
Ware, Norton San Francisco, Calif.
Warren, Walter B. Portland, Ore.
Weaver, Earl C. Ashland, Ore.
Weber, A. G. Berkeley, Calif.
Weber, F. D. Portland, Ore.
Webster, Fred L. San Francisco, Calif.
Webster, Geo. S. Philadelphia, Pa.
Weeks, F. B. San Francisco, Calif.
Weigart, L. G. Oakland, Calif.
Wells, J. B. Palo Alto, Calif.

West, Chas. H. Ogden, Utah
West, H. E. Santa Barbara, Calif.
Weymouth, C. R. San Francisco, Calif.
White, Frank G. San Francisco, Calif.
White, Lazarus New York, N. Y.
Whitesel, H. H. Akron, Ohio
Whitney, C. W. San Francisco, Calif.
Whittle, Geo. D. Sacramento, Calif.
Whittlesey, J. T. Berkeley, Calif.
Wieland, C. F. San Francisco, Calif.
Wilder, A. D. Berkeley, Calif.
Wilhelm, Geo. T. Denver, Colo.
Williams, Jr., Cyril San Francisco, Calif.
Williams, Gardner F. Washington, D. C.
Williams, Gardner S. Ann Arbor, Mich.
Williams, H. L. Salt Lake City, Utah
Williams, W. A. San Francisco, Calif.
Wilson, Chas. J. Piedmont, Calif.
Wilson, W. A. Salt Lake City, Utah
Wing, Chas. B. Palo Alto, Calif.
Winterhalter, W. K. San Francisco, Calif.
Wiseman, Philip Los Angeles, Calif.
Wiskocil, C. T. Berkeley, Calif.
Wolf, Julius H. G. San Francisco, Calif.
Wolflin, Hugh M. San Francisco, Calif.
Wong, R. B. Palo Alto, Calif.
Woodbridge, J. E. San Francisco, Calif.
Woodbridge, T. R. Upland, Calif.
Woolson, Ira H. New York, N. Y.
Wrampelmeier, E. L. S. Berkeley, Calif.
Wray, J. G. Chicago, Ill.
Wright, W. Q. San Francisco, Calif.
Wuth, Berthold Oakland, Calif.
Wyckoff, Homer J. Detroit, Mich.

Foreign Countries

Argentina

Anasagasti, Horacio Buenos Aires

Australia

Jones, Leo J. Sydney
Wilson, Ron. Martin Brisbane

Austria

Breinl, J. C. Pribram

Brazil

Charnley, Walter Sao Paulo

Canada

Allen, C. W. Ottawa
Campbell, R. H. Ottawa
Challies, J. B. Ottawa
Cowin, James Winnipeg
Drake, E. F. Ottawa
Hall, Oliver Coniston
Houston, Gavin N. Calgary
Lachmund, Oscar Greenwood
Mitchell, Percival H. Toronto
Muckleston, H. B. Calgary
Murphy, John Ottawa
Peters, F. H. Calgary
Souba, W. H. Regina
Steven, H. M. Timmins
Sullivan, J. H. Winnipeg
Wilson, Alfred W. G. Ottawa

China

Chen, C. S. Peking
Chu, Y. P. Tientsin
Panhoe, H. A. Canton
Wei, Han Peking
Yen, Chi-Yi Tientsin

Cuba

Aguilera, E. Santiago
Bango, Rafael Garcia Havana
Gaston, Eduardo Havana
Gaston, Francisco Havana
Muxo, Augusto G. Havana
Rodriguez, Santiago Havana
Rojas, H. Havana
Villalon, José R. Havana

France

de Pulligny, Jean L. Paris

Germany

Schlenzig, T. Berlin

Guatemala

Cruz, Fernando Guatemala City

India

Seshasayee, R. Trichinopoly

Japan

Furuichi, Tatsuo Tokyo
Hirabayashi, Takeshi Toyko

Hirai, Kikumatsu Tokyo
Kondo, Motoki Tokyo
Mayehara, S. Tokyo
Nakagawa, Shin Tokyo
Nakamura, H. Shimotsuke
Takahashi, T. Taipeh

Mexico

Foester, Hallard W. Esqueda
Green, H. E. Esperanza
Swain, H. L. Mexico
Ugarte, Salvador Guadalajara

Nicaragua

Cantón, A. San Francisco
Parker, S. M. La Libertad

Scotland

French, James Glasgow

Spain

Campalans, Raphael Barcelona
de Lasarte, D. Jose Barcelona

Sweden

Bernstrom, Richard Stockholm
Bostrom, Hj. Gelfe
Hallén, Knut Orebro
Körner, Julius Vasteras
Sandelin, Folke Wikmanshyttan
Seymer, Arvid Stockholm
Torjeson, T. A. Stockholm
von Greyerz, Walo Stockholm

Switzerland

Nissler, Franz Fribourg
Rohn, Arthur Zürich

The Netherlands

de Jongh, C. A. Arnhem
Snellen, Robert Amsterdam
Wenckebach, H. J. E. The Hague

Venezuela

Tinsley, R. B. Guanoco

Total Registration, 815.

THE EVENTS OF THE CONGRESS

Headquarters

On September 13, a week before the opening of the Congress, headquarters for the registration and general accommodation of members were established in a large vacant store at 56 Post Street, a few doors from the Foxcroft Building, in which the executive offices of the Congress were located. These headquarters were in charge of Mr. G. M. Brill, M. Am. Soc. M. E. and Mem. A. I. E. E. Thanks to his energy and efficiency, they were comfortably fitted up at small cost with desks, tables, chairs, rugs, telephones, typewriters, etc., and were maintained in operation until the close of the Congress, on September 25.

Mr. Brill was ably assisted in the management of headquarters by Mr. LeGrand Brown, M. Am. Soc. C. E., Mr. Myron H. Peck, M. Am. Soc. C. E., Mr. W. C. Miller, Jr., Assoc. A. I. E. E., and Mr. C. F. Wieland, Mem. Am. Soc. M. E., and several members of the clerical staff from the executive offices of the Congress who were transferred for the two weeks' period to headquarters.

Representatives of the Southern Pacific Company and the Tourists' Association were in attendance to validate tickets, make Pullman reservations and to supply information as to transportation, etc. A representative of the McGraw Publishing Co. was on hand to distribute gratis to members and visitors technical literature and maps, which they had prepared especially for the occasion.

During the two weeks in which the headquarters were maintained, a total of 815 members of the Congress registered and made definite arrangements for participating in the various excursions and social functions which had been arranged by the Congress committee. During this entire period, the headquarters were used as a club room and meeting place for members and visitors, and were the scene of continued activity.

Excursions Preceding the Congress

As the date of the Congress approached, the Local Affairs Committee, with Mr. Thos. Morrin as Chairman, was increased in size and became active in arranging for the various excursions and social events which were held in connection with the

Congress. Many conferences were held with the local committees of the engineering societies which were to hold conventions in San Francisco in the week preceding the Congress, and nine different excursions to points of engineering interest in San Francisco and California were scheduled for the interim between the closing of the individual society conventions and the opening of the Congress. These excursions were open alike to members of the Congress, members of the individual societies and invited guests.

Excursion No. 1-a—The San Francisco High-pressure Fire System.

On Saturday, September 18, Mr. T. W. Ransom, Consulting Mechanical Engineer of the city of San Francisco, conducted a party of thirty-six members and guests of the Congress over the high-pressure fire system. The trip was made in automobiles, starting from the Palace Hotel at 9:15 a. m. A visit was first made to the fire boats at Harrison Street Wharf; then to Pumping Station No. 1; then through the Stockton St. Tunnel to the Jones St. Tank and to Pumping Station No. 2, which, through the courtesy of Fire Chief Murphy, was operated to its full capacity of 12,000 gallons per minute for the entertainment of the visitors. The party then visited the Central Fire Alarm Station, the Twin Peaks Reservoir and Ingleside Terrace, where, through the courtesy of Mr. Joseph Leonard of the Urban Development Co., luncheon was served.

After inspecting Ingleside Terrace and St. Francis Wood, the party visited the west portal of the Twin Peaks Tunnel, now under construction. The return trip was made via Sloat Boulevard, the Great Highway, the Cliff House and Golden Gate Park to the Municipal Car Barn, Geary St. and Presidio Ave. After inspecting the car barn, the party returned to the Palace Hotel, which was reached about 4:30 p. m. The automobiles for the trip were furnished by Mr. John W. Plant, Mr. William Haskan, Mr. G. I. Gay, Mr. Charles M. Black, the Board of Public Works, the Board of Supervisors and the Board of Education.

Excursion No. 1-b—Gas and Electric Plants.

On Saturday morning, September 18, a party of thirty members and guests of the Congress, including several ladies,

assembled at the Palace Hotel and were transported in automobiles, furnished by the courtesy of the Pacific Gas & Electric Company, to the Potrero Gas Works, where they were afforded an opportunity of inspecting every portion of the works from the generating room to the compressors, where gas is sent out under high pressure.

Two oil gas generators of the Improved Jones Type, each with a daily capacity of six million cubic feet, are installed at this station.

The trip was in charge of Mr. E. C. Jones, the Chief Engineer of the Gas Dept. of the P. G. & E. Co., and the inventor of the Jones Type of Generators.

Excursion No. 2—Spring Valley Water Co. Properties on the East Side of San Francisco Bay.

On Saturday, September 18, forty-five members and guests of the Congress were taken on a trip of inspection of the infiltration galleries at Sunol and the Calaveras Dam of the Spring Valley Water Company. The dam is now in process of construction.

The party left the San Francisco Ferry building via Western Pacific ferry and train at 8:30 a. m., and proceeded to Sunol, where they were met by automobiles provided by the courtesy of the Spring Valley Water Co.

The trip was in charge of Mr. G. A. M. Elliott, Engineer of the Company.

Excursion No. 3—Spring Valley Water Co. Storage Reservoirs and Pumping Stations on the San Francisco Peninsula.

On September 19, at 8:30 a. m., one hundred and twenty-nine members and guests of the Engineering Congress went to San Mateo by train, where they were met by automobiles provided by the courtesy of the Spring Valley Water Co., and taken over the following properties of that company:

The Belmont pumps (22,000,000 gallons daily capacity), the Upper Crystal Springs earth dam, the Lower Crystal Springs concrete dam and the San Andreas earth dam.

Considerable interest was manifested in these structures, particularly the earth dams, through which the fault line of the earthquake of 1906 passes. Through the courtesy of the Water Company, a barbecue was given the members of the

party at Sawyer Camp. Mr. G. A. M. Elliott, Engineer of the Company, was in charge of the trip.

Excursion No. 4—The Delta Lands of the Sacramento and San Joaquin Rivers.

On Sunday, September 19, a party of twenty-six members of the Congress left San Francisco on the 7:00 a. m. Santa Fe train for Stockton, where they were met by members of the Chamber of Commerce with automobiles and taken for a tour of inspection of Stockton and the surrounding country. An additional party of twenty-three, leaving on the nine o'clock train, were met in Stockton by automobiles, and were taken to the steamer "Leader" at the head of Stockton Channel. At Stockton these two parties were augmented by a number of local residents and by members of the Irrigation Congress, then in session in Sacramento. In all, there were about eighty people on board the "Leader" when she left Stockton at 1:00 p. m.

The course of the steamer was down the San Joaquin River to the head of Sherman Island; thence up Three Mile Slough to the Sacramento River, where the Government suction dredgers are working on the enlargement of the Sacramento River in conformity with the general flood-control plan; thence down the Sacramento River, around the lower end of Sherman Island to Antioch. At Antioch sixty-one of the party took the train on the return trip to San Francisco, arriving about 11:00 p. m.

The attendance on this trip was about equally divided between the members of the International Engineering Congress, delegates to the National Drainage Congress, delegates to the Irrigation Congress and prominent citizens of Stockton and vicinity.

The trip was arranged and conducted by Mr. Edwin F. Haas, C. E., M. Am. Soc. C. E.

Excursion No. 5—Great Western Power Company's Hydroelectric Plant at Las Plumas.

On Friday, September 17, a party of five members and guests of the Congress left in a special Pullman car attached to the 8:00 p. m. train of the Western Pacific Railway, accompanied by a representative of the Great Western Power Co. The car was side-tracked at Las Plumas at 2:30 a. m. Shortly after seven o'clock the party breakfasted at the Club House,

and were then afforded an opportunity of inspecting the company's hydroelectric development at Big Bend.

At 10:45 that morning, the special Pullman was attached to the westbound Western Pacific train, and the party reached San Francisco at 4:30 p. m. The trip was arranged by Mr. W. W. Briggs, General Agent of the Great Western Power Company.

Excursion No. 6-a—Lake Spaulding and Drum Power House.

On the evening of September 17, seventeen members and guests of the Congress left San Francisco in a special Pullman sleeper, which arrived at Smart about 6:30 on the morning of the 18th. The morning was spent in inspecting the concrete dam, outlet tunnels, gates, etc. After luncheon the members of the party were taken to the Drum Power House, where they spent the afternoon in inspecting the forebay, pipe lines and power station. After dinner at the power house, the party returned to the car, which was then attached to the regular Southern Pacific train, and reached San Francisco Sunday morning, the 19th.

This trip, which was most interesting and agreeable for all the members and guests, was in charge of Mr. Paul Downing, Chief Engineer of the Hydroelectric Department of the Pacific Gas & Electric Company.

Excursion No. 6-B—Gold Mines at Grass Valley.

On Friday, September 17, twenty members and guests of the Congress left San Francisco by special sleeper, arriving at Grass Valley at 10:00 a. m. on the 18th. The party was personally conducted by Mr. Robert Bedford of the North Star Mine. The day was spent in inspecting the mines and mills at Grass Valley, local members of the American Institute of Mining Engineers acting as reception committee and guides.

The party left Grass Valley early in the evening, reaching San Francisco about 8:00 a. m. Sunday morning, September 19, as per schedule. The trip to Grass Valley was arranged by Messrs. A. A. Hanks and C. G. Davis, Members A. I. M. E.

Excursion No. 7—Oil Fields at Coalinga.

Owing to the various other attractions, only two members of the Congress, Mr. Pratt of the Government Bureau in the

Philippines, and Mr. Jones of the Geological Survey in New South Wales, accompanied by Mr. A. F. Bell of the Associated Oil Company, availed themselves of the opportunity to visit the Coalinga Oil Fields.

Both of the visiting members expressed a desire to see the geological side of the industry, and the greater part of the day was spent on formations. Mr. Hively of the Kern Trading and Oil Company entertained the party at lunch.

The afternoon was spent in a general inspection of the oil fields, pumping, well-drilling, camps, shops, etc., and the new pump station and tank farm, including a 750,000-bbl. cement-lined reservoir of the Dutch Shell Company.

General Program of the Events of the Congress.—

Monday, September 20, 10:00 A. M.
Opening General Session, in Main Hall of Auditorium Building, Civic Center; Hayes, Larkin and Market Sts., San Francisco.

Monday, September 20, 2:00 P. M.
General Session:—The Panama Canal. In Main Hall of Auditorium.

Monday, September 20, 8:30 P. M.
Reception to Visiting Members, at Palace Hotel, Market and New Montgomery Sts.

Tuesday, September 21, 9:00 A. M.
Mount Tamalpais Trip.

Tuesday, September 21, 10:00 A. M.
Section Sessions in various Halls of the Auditorium.

Tuesday, September 21, 2:00 P. M.
Section Sessions in various Halls of the Auditorium.

Wednesday, September 22, 10:00 A. M.
Section Sessions in various Halls of the Auditorium.

Wednesday, September 22, 2:00 P. M.
Visit to Exposition, Grounds and Palaces.

Thursday, September 23, 10:00 A. M.
Section Sessions in various Halls of the Auditorium.

Thursday, September 23, 2:00 P. M.
Section Sessions in various Halls of the Auditorium.

Thursday, September 23, 2:30 P. M.
Lawn Party on the Grounds of the University of California.

Friday, September 24, 10:00 A. M.
Section Sessions in various Halls of the Auditorium.

Friday, September 24, 10:00 A. M.
Automobile ride for Ladies.

Friday, September 24, 2:00 P. M.
Section Sessions in various Halls of the Auditorium.

Friday, September 24, 7:00 P. M.
Banquet at Palace Hotel.

Saturday, September 25, 10:00 A. M.
Closing General Session in Main Hall, Auditorium.

Saturday, September 25, 2:00 P. M.
Cruise about San Francisco Harbor.

Sessions and Attendance

The sessions of the International Engineering Congress began on Monday morning, Sept. 20, with an opening general session. This was followed on Monday afternoon with a section session on the Panama Canal.

On Tuesday, and the following days of the week until Saturday morning, the Congress divided into several parallel sessions, as noted on the program. The attendance at the various section sessions ranged from fifty to four hundred. It would be difficult to determine the attendance at any one session with accuracy, as the members and visitors came and went during the sessions. As already noted, the total registration at Congress Headquarters was 815; in addition to the registered members (many of whom were accompanied by the ladies of their families) about 600 cards of admission were issued to the Senior and Junior students of the Universities, and it is estimated that in all about 2,000 persons were in attendance at one or more of the sessions of the Congress.

The Congress closed with a general session on Saturday morning, following the section sessions on Waterways and Irrigation and Electrical Engineering.

All sessions were held in the Civic Center Auditorium, which was erected by the Exposition management for the free

use of the congresses and conventions during the Exposition year.

Opening General Session.—At the opening general session, on Monday morning, some fifty delegates were in attendance, and about eight hundred members and visitors. The meeting was called to order by Dr. W. F. Durand, Chairman of the Committee of Management. After a brief address, reviewing the origin and development of the Congress, Doctor Durand introduced Major-General George W. Goethals, the Governor of the Canal Zone, and invited him to take the chair as Honorary President of the Congress.

Addresses of welcome to the delegates and members were then made by Mayor James Rolph, Jr., of San Francisco, and President C. C. Moore of the Panama-Pacific International Exposition, after which President Goethals made his address, which was enthusiastically received.

Addresses were also made by the following foreign delegates:

Major J. L. de Pulligny, of France
Señor S. Villalon, of Cuba
Mr. J. B. Challies, of Canada
Admiral Wei-Han, of China
Señor Don Fernando Cruz, of Guatemala
Admiral M. Kondo, of Japan
Mr. H. J. E. Wenckebach, of the Netherlands
Señor Don Alejandro Cantón, of Nicaragua.
Señor Don J. de Lasarte, of Spain
Mr. Richard Bernstrom, of Sweden
Prof. Arthur Rohn, of Switzerland

All of these speeches were reported stenographically and are to be found elsewhere in this volume.

At the afternoon session of Monday, before which papers on the Panama Canal were presented, General Goethals presided in person, and there were present about eight hundred members and visitors.

The Section Sessions.—At the various sessions, papers were read in full, in abstract or presented by title as the time available and the nature of the paper warranted. Many of the

papers were presented by the authors in person, others by the secretaries of the sections.

After the presentation of a paper, opportunity was afforded for oral discussion, and when the available time permitted, written discussions which had previously been received were read by the writers or the section secretaries.

A full report of the proceedings at each section would be tedious and is deemed unnecessary. The papers presented, together with such discussions, both written and oral, as were deemed to be of permanent value, appear in the transactions of the Congress.

SCHEDULE OF SECTION SESSIONS

		I—Panama Canal	II—Waterways and Irrigation	III—Municipal Engineering	IV—Railways and Railway Engineering	V—Materials of Engineering Construction	VI—Mechanical Engineering	VII—Electrical Engineering and Hydroelectric Power Development	VIII—Mining	IX—Metallurgy	X—Naval Architecture and Marine Engineering	XI—Miscellany
Mon.	A. M.											
"	P. M.	1										
Tues.	A. M.		1		1	1	1		1		1	
"	P. M.		2	1	2	2	2			1	2	
Wed.	A. M.		3	2		3	3		2		3	1
"	P. M.											
Thur.	A. M.		4	3	3	4		1	3	2	4	
"	P. M.		5		4	5	4	2		3	5	2
Fri.	A. M.		6	4	5		5			4	6	3
"	P. M.		7	5			6			5	7	4
Sat.	A. M.		8					3				

Following is a list of those who acted as Chairmen and Secretaries of the various Sections:

Section	Session	Chairman	Secretary
General	Opening	W. F. Durand G. W. Goethals	W. A. Cattell E. J. Dupuy
Panama Canal	1	G. W. Goethals J. L. de Pulligny	W. A. Cattell
Waterways	1	G. W. Goethals	Edwin Duryea, Jr.
Waterways	2	C. D. Marx	Edwin Duryea, Jr.
Waterways	3	C. McD. Townsend	Edwin Duryea, Jr.
Waterways	4	C. McD. Townsend	Edwin Duryea, Jr.
Irrigation	5	C. D. Marx Elwood Mead	B. A. Etcheverry
Irrigation	6	Elwood Mead	B. A. Etcheverry
Irrigation	7	P. M. Norboe Elwood Mead	B. A. Etcheverry
Irrigation	8	Elwood Mead C. D. Marx	B. A. Etcheverry
Municipal	1	M. M. O'Shaughnessy	T. W. Ransom
Municipal	2	Geo. W. Fuller	T. W. Ransom
Municipal	3	M. M. O'Shaughnessy	T. W. Ransom
Municipal	4	M. M. O'Shaughnessy	T. W. Ransom
Municipal	5	Chas. H. Hyde	T. W. Ransom
Railways	1	Geo. H. Pegram	W. A. Cattell
Railways	2	Chas. S. Churchill	W. A. Cattell
Railways	3	Chas. F. Loweth	W. A. Cattell
Railways	4	Arnold Stucki	W. A. Cattell
Railways	5	William Hood	W. A. Cattell
Materials	1	Mansfield Merriman	C. B. Wing
Materials	2	Mansfield Merriman	C. B. Wing
Materials	3	Mansfield Merriman	C. B. Wing
Materials	4	Mansfield Merriman	C. B. Wing
Materials	5	Wm. H. Shockley	C. B. Wing
Mechanical	1	Geo. W. Dickie	W. R. Eckart, Jr.
Mechanical	2	Calvin W. Rice	W. R. Eckart, Jr.
Mechanical	3	Geo. W. Dickie	W. R. Eckart, Jr.
Mechanical	4	W. R. Eckart, Jr.	W. R. Eckart, Jr.
Mechanical	5	Geo. W. Dickie	W. R. Eckart, Jr.
Mechanical	6	W. L. Saunders	W. R. Eckart, Jr.
Electrical	1	J. J. Carty	J. T. Whittlesey
Electrical	2	J. Franklin Stevens	J. T. Whittlesey
Electrical	3	H. J. Ryan	J. T. Whittlesey
Mining	1	W. L. Saunders	A. K. P. Harmon, Jr.
Mining	2	W. L. Saunders	A. K. P. Harmon, Jr.
Mining	3	(Combined with Session No. 2)	
Metallurgy	1	J. W. Richards	G. H. Clevenger
Metallurgy	2	L. D. Ricketts	G. H. Clevenger
Metallurgy	3	L. D. Ricketts	G. H. Clevenger
Metallurgy	4	Chas. Butters	G. H. Clevenger
Metallurgy	5	E. B. Braden	G. H. Clevenger
Naval Arch.	1	W. L. Capps	E. P. Lesley
Naval Arch.	2	W. L. Capps	E. P. Lesley
Naval Arch.	3	W. L. Capps	E. P. Lesley
Naval Arch.	4	W. L. Capps	E. P. Lesley
Naval Arch.	5	W. L. Capps	E. P. Lesley
Naval Arch.	6	W. L. Capps	E. P. Lesley
Naval Arch.	7	W. L. Capps	E. P. Lesley

Section	Session	Chairman	Secretary
Miscellany	1	W. F. Durand	Jos. N. Le Conte
Miscellany	2	Theo. O. Vilter	Jos. N. Le Conte
Miscellany	3	C. D. Marx / Mansfield Merriman	Jos. N. Le Conte
Miscellany	4	W. F. Durand	Jos. N. Le Conte
General	Closing	W. F. Durand	W. A. Cattell

Reporting Discussions.—In order to save the large expense of reporting stenographically the fifty-two technical sessions of the Congress, and at the same time to secure a prompt report of the salient features of the oral discussions, and without the labor and delay incident to the revision of verbatim stenographers' reports, it was arranged to have the reporting done by the professors and instructors of the University of California and Leland Stanford Jr. University, assisted by students of the Senior classes.

In the main, this plan worked very well; most of the reports were received promptly, and in such shape that they could be easily revised for technical publication, or serve as a basis for amplification or revision by the speakers, for final publication in the Transactions of the Congress.

This work was performed gratuitously on the part of the professors and their student assistants, and the Committee of Management feels itself much indebted to all of these gentlemen for the valuable services rendered.

Following is a list of the professors and instructors who aided in this work.

From the University of California:

Prof. W. S. Weeks
Mr. L. C. Uren
Prof. E. A. Hersam
Prof. W. S. Morley
Prof. B. F. Raber
Prof. H. F. Fischer
Prof. F. E. Pernot
Prof. R. S. Tour
Mr. B. R. Vanleer
Prof. H. B. Langille
Prof. W. F. Martin
Prof. B. M. Woods
Prof. F. S. Foote, Jr.
Prof. A. C. Alvarez
Prof. H. S. Griswold
Prof. A. J. Eddy
Mr. R. A. White
Mr. C. T. Wiskocil
Prof. S. T. Harding

From Stanford University:

Prof. G. N. Cross
Prof. L. E. Cutter
Mr. H. W. Stebbins
Prof. L. Reynolds
Prof. J. C. L. Fish
Prof. J. C. Clark
Prof. V. R. Garfias

Closing General Session.—The closing general session was held at 11:30 a. m. Saturday, September 25, Dr. W. F. Durand acting as Chairman. There were present about thirty delegates and 500 members of the Congress.

Doctor Durand spoke briefly regarding the purposes of the Congress, of the Transactions to be published and the noble response which the engineers of the world had made to the request for papers.

A cablegram of greetings from the Congress to the family of Ferdinand de Lesseps, the builder of the first great interoceanic canal, was read and approved by acclamation.

Speeches were then made by Prof. Charles D. Marx, President of the American Society of Civil Engineers;

Dr. J. A. Brashear, President of The American Society of Mechanical Engineers;

Mr. J. J. Carty, President of the American Institute of Electrical Engineers;

Major Jean L. de Pulligny, representing the Republic of France;

Mr. J. G. Sullivan, Chief Engineer of the Canadian Pacific Railway;

Admiral Wei-Han, of China;

Señor Don Fernando Cruz, of Guatemala;

Admiral M. Kondo, of Japan;

Mr. H. J. E. Wenckebach, of The Netherlands;

Señor Alejandro Cantón, of Nicaragua;

Señor J. M. de Lasarte, of Spain;

Señor Jose R. Villalon, of Cuba.

Dr. Brashear moved a vote of thanks to Doctor Durand and those who were associated with him in the work of developing and conducting the Congress, which was unanimously carried.

Doctor Durand then declared the Congress adjourned "without a day".

These speeches were stenographically reported and are to be found elsewhere in this volume.

Social Functions and Excursions During the Congress

While the technical sessions of the Congress were, perhaps, of first importance, the social functions and excursions which were arranged in connection with the Congress were most successful and enjoyable.

Reception.—The Reception on Monday night was a brilliant and enjoyable affair, and was attended by General Goethals, the chief guest of honor, most of the foreign and American delegates, and many of the most prominent engineers of America with their families.

In addition to General Goethals, the guests of honor were:

Dr. W. F. Durand, Chairman of the Committee of Management; Major Jean L. de Pulligny, Delegate from the French Government; Brigadier General W. L. Sibert, representing the U. S. Army; Mr. Arthur Arlett, representing the Governor of California; Prof. Chas. D. Marx, President, Am. Soc. C. E., and Mrs. Marx; Mr. M. M. O'Shaughnessy, City Engineer, representing the Mayor of San Francisco, and Mrs. O'Shaughnessy; Mr. W. L. Saunders, President, Am. Inst. M. E.; Mr. John A. Britton, representing the Panama-Pacific International Exposition; Dr. J. A. Brashear, President, Am. Soc. M. E.; Mr. G. W. Dickie, Vice-President Am. Soc. M. E., and Mrs. Dickie and Miss Dickie; Captain F. M. Bennett, representing the U. S. Navy, Mrs. Bennett and Miss Bennett; Mr. J. J. Carty, President, Am. Inst. E. E.; Prof. H. J. Ryan, Vice-President, Am. Inst. E. E., and Mrs. Ryan; J. O. Davis, Collector of Port of San Francisco, and Mrs. Davis; Rear Admiral W. L. Capps, U. S. Navy, and Mrs. Capps.

Mr. E. B. Bumsted served as Chairman of the Reception Committee.

Trip to Mt. Tamalpais.—On September 21, seventy-five members and guests of the Congress took the 9:15 a. m. boat for Sausalito, and proceeded thence by train to Mill Valley, where they boarded the Mt. Tamalpais Railway train for the

trip up the mountain, from which the fine view of San Francisco City and Bay and the surrounding country was enjoyed.

After luncheon the party descended by a gravity train to Muir Woods, the interesting features of which were shown them by a guide.

The trip was arranged and conducted by Mr. R. F. Chevalier.

Visit to the Exposition.—On Wednesday afternoon, September 22, about 200 of the members of the Congress and their ladies assembled at the southerly end of the Palace of Machinery in the Panama-Pacific International Exposition grounds. Here they divided into groups to visit exhibits of special interest in the various palaces. By far the greater number remained in the Palace of Machinery, and under the general direction of Lt. Geo. W. Danforth, U. S. N., Chief of the Division of Machinery of the Panama-Pacific International Exposition, assisted by members of the local committee of the Congress, were guided to the exhibits in which they were most interested.

Nearly all the larger exhibitors of machinery and engineering materials and supplies had, for the occasion, special technical representatives in attendance to explain their exhibits, so that the afternoon was spent most profitably as well as pleasantly.

This was the only official visit of the Congress to the Exposition, and the entire afternoon was spent in this general tour of inspection.

During the tour of the Palace of Machinery, Mr. Chas. A. Vogelsang, on behalf of the Directors of the P. P. I. E., presented to Professor Durand, as Chairman of the Committee of Management of the Congress, a commemorative bronze plaque.

Lawn Party.—On the afternoon of September 23, about 500 members and guests assembled in the "Faculty Glade" on the grounds of the University of California, for an informal reception and lawn party. Music was provided by an Hawaiian orchestra of six pieces, and light refreshments were served.

During the afternoon a conveyance was in service, in which, under the guidance of Professor C. G. Hyde, visitors were driven about the grounds and an opportunity thus af-

forded of inspecting the Campus and various University buildings.

Later in the afternoon, an opportunity was given, to all who desired, to ascend in the elevator to the top of the campanile, recently constructed for the University under the supervision of Prof. Chas. Derleth, Jr.

Mrs. C. E. Grunsky was Chairman of the Ladies' Committee which arranged the lawn party.

Automobile Trip.—On the morning of September 24, 76 members and guests of the Congress, principally ladies, left the Civic Center Auditorium in seventeen touring cars for a ride to points of interest in the city. The time consumed by the trip was something over three hours. The route was along the Exposition Grounds through the Presidio Military Reservation, past the Marine Hospital, Lincoln Park, Sutro Heights and the Cliff House, Seal Rocks and the Beach, St. Francis Wood, the west portal of the Twin Peaks Tunnel, Twin Peaks, from which a delightful panoramic view of San Francisco and the Bay was obtained, and the Golden Gate Park. In passing through St. Francis Wood, each lady was presented with a small and attractive bouquet, with the compliments of the Mason-McDuffie Company.

The trip was arranged and conducted by Mr. G. I. Gay, and was most enjoyable and successful in every way.

Banquet.—On the evening of Friday, September 24, two hundred and sixty-six members and invited guests of the Congress sat down to a dinner in the ball room of the Palace Hotel. An excellent menu was provided; the room and tables were beautifully decorated, appropriate music was rendered by the hotel orchestra during the serving of the dinner, and afterwards vocal selections were rendered by talented artists.

The banquet was given by the Committee of Management to the Honorary President and Vice-Presidents of the Congress. Unfortunately, General Goethals was not present, having earlier in the week been called back to Washington, on his way to the Canal Zone. The Honorary Vice-Presidents were represented by Major Jean L. de Pulligny, the only Vice-President who was able to attend the Congress.

The most enjoyable feature of the evening was the general

tone of good fellowship and appreciation of the results of the Congress which prevailed throughout.

Dr. W. F. Durand acted as toastmaster, and after a brief address, in which he compared the Congress to a comet with a recurrent period of eleven years, then at the moment of perihelion, proceeded to introduce the speakers of the evening in appropriate words.

The speakers were:

Major Jean L. de Pulligny, representing the Honorary Vice-Presidents of the Congress;

Brig. General W. L. Sibert, representing the U. S. Army;

Prof. Chas. D. Marx, President of the Am. Soc. of C. E., representing the five supporting societies;

Mr. Chester H. Rowell, representing the Governor of California;

Mr. M. M. O'Shaughnessy, City Engineer, representing the city of San Francisco;

Mr. Henry T. Scott, representing the Board of Directors of the Panama-Pacific International Exposition;

Mr. Benjamin Ide Wheeler, representing the University of California.

Others seated at the speakers' table were:—

Admiral M. Kondo, of Japan
Prof. Arthur Rohn, of Switzerland
Dr. Ing. Ralph Campalans, of Spain
Mrs. Benj. Ide Wheeler
Rear Admiral W. L. Capps, U. S. Navy
Señor J. R. Villalon, of Cuba
Baron W. Forstner, of The Netherlands
Mrs. M. M. O'Shaughnessy
Mr. Julius Körner, of Sweden
Mr. W. A. Cattell, Sec.-Treas. of the Committee of Management.

Vice-Admiral Wei-Han of China and Mr. and Mrs. J. G. Sullivan of Canada, for whom seats at the speakers' table had been provided, were not able to be present.

Mr. W. W. Briggs was Chairman of the Banquet Committee.

The Cruise about San Francisco Harbor.—The last event of the Congress, following the general closing session on Saturday morning, was a trip by steamer around the Bay, which was given by the courtesy of the Board of State Harbor Commissioners, of which Mr. Jerome Newman, M. Am. Soc. C. E., is Chief Engineer. The steamer "Arrow" was chartered for the occasion, and left pier No. 14, at the foot of Mission Street, shortly after 3:00 p. m., with 320 members and ladies on board. A run to the south as far as Hunter's Point Dry Docks was made, then past the Ferry Building, the Exposition Grounds, the Golden Gate and around Angel Island; the return landing being made at 4:30 p. m.

The trip was in charge of Mr. Jerome Newman, who personally explained points of interest visible from the steamer.

Report of the Opening Session.—Monday, Sept. 20, 10 a. m.

The convention was opened by Dr. William F. Durand, Chairman, who requested all delegates to the Congress to take seats on the platform.

Chairman Durand.—Gentlemen of the Congress: This moment marks the fruition of nearly four years of hope and preparation on the part of the engineers of San Francisco and of the Committee of Management of the Congress, all directed toward the holding of an international engineering congress in San Francisco in 1915 on the occasion of the Panama-Pacific International Exposition, which itself signalizes the completion of the Panama Canal and its opening up as a great highway of commerce.

In the brief moments which I shall occupy on this occasion, it seems not improper to outline, in broad terms, the history of the inception of the Congress, its organization and development, and its status at the moment of entering upon its six-day period of active existence.

The credit for the inception of the Congress belongs to no one man or to no one group or organization of men. With the Panama-Pacific International Exposition assured, there naturally sprang up in the minds of the engineers of San Francisco and vicinity hopes of holding a great engineering congress, a gathering together of engineers from all countries of the world,

and from all parts of the broad field of engineering work, for the purpose of taking counsel together of the things of their profession.

The thought of an engineering congress was, in truth, in the air. It occupied the thoughts of engineers individually, and was talked of by engineers in groups and in our local societies. These hopes soon took form in a meeting, in October, 1911, of representatives of two of the local societies, at which it was decided to call a conference of engineers representing some eight local engineering and scientific societies on the Pacific Coast.

At this meeting, held on November 2, 1911, it was decided to ask the governing bodies of these societies, with two additional, to appoint delegates to a convention called to meet on January 15, 1912, whose duty it should be to consider and report on the advisability of holding an international engineering congress in San Francisco in 1915, and, if advisable, to consider and recommend a plan of organization and management for the same.

This convention reported unanimously in favor of holding such a congress, and after conference and consideration extending over most of the following year, the present form of organization was completed and adopted by the national societies concerned.

According to this plan, into the details of which I need not here enter, the Congress was to be organized and managed by the five national engineering societies, as follows: American Society of Civil Engineers, American Institute of Mining Engineers, The American Society of Mechanical Engineers, American Institute of Electrical Engineers, The Society of Naval Architects and Marine Engineers.

To this end a joint committee was appointed, representing these societies, and clothed with full power with regard to all matters pertaining to the Congress.

This committee of management, with headquarters in San Francisco, has been actively at work about two and one-half years. It has communicated, in one way or another, with some 175,000 professional engineers located in all parts of the world, and with some 300 engineering and scientific societies in all countries,—thus placing before the engineers of the world,

individually and collectively, the plans and purposes of the Congress and inviting their participation and help.

The deplorable conditions in Europe, which arose a little more than a year ago, introduced a factor of grave menace into the plans for the Congress. Such conditions were certain to affect most seriously the extent of foreign participation, both in attendance and in papers. The Congress had, however, been widely announced; already more than 100 writers had accepted invitations and were engaged in the preparation of their papers. In the face of these conditions, it seemed to the Committee of Management that the only thing possible was to go forward, making the best of the situation, and to show to the world that an international congress of engineers could be held, notwithstanding the cataclysm which seems to engulf so many of the nations of Europe.

We trust that the results, as the meetings of the week shall proceed, may justify our faith.

Taking, for a brief moment, note of the material which has been thus gathered for your consideration, and of the extent of foreign participation in the activities of the Congress, the following items may be mentioned.

There have been received in time for publication in pamphlet form and ready for your consideration during the week, some 210 papers.

There have been received too late for publication in pamphlet form, but to be read by title or abstract from the manuscript, some 30 additional papers.

These papers with discussions will be published in eleven volumes and will include over 7,000 pages of printed matter.

They represent some 18 countries, distributed in all continents and over the civilized world.

This material will form the subject matter for your deliberations during the coming week, distributed through the 52 different sessions, as indicated on the program.

But engineering congresses do not happen. In the usual order of things, they must be arranged coincident in time and place with some great international movement or interest, such as the Exposition which San Francisco is celebrating during the year 1915. But, again, international expositions need some compelling motive, some central idea to give form, coherence

and purpose. And as such central idea, the Panama-Pacific International Exposition is fortunate in having the Panama Canal —its completion and opening to the commerce of the world.

It is therefore but natural that the central inspiration of this engineering congress has been furnished by the Panama Canal, and by the recent progress and present status of the engineering arts which have, in these latter years, rendered possible such a gigantic undertaking.

And when, as engineers, we speak or think of the Panama Canal, our thoughts instinctively turn to the great Chief whose hand and brain have directed and brought to a successful conclusion that great engineering undertaking. (Applause.) And so it was but natural that the Committee of Management of the Congress should invite this leader among engineers to preside, as Honorary President, over the deliberations of this body—an invitation which was graciously accepted; and so, at the crowning moment of this long period of hope and preparation, I have the honor to present to you as the Honorary President of the Congress, General George W. Goethals, late Chief Engineer of the Panama Canal and Chairman of the Panama Canal Commission, and now Governor of the Panama Canal Zone. (Applause.)

President Goethals.—Gentlemen: I sincerely appreciate the compliment contained in your choice of me as your Honorary President, even though it may seem that your choice of the present executive of the Panama Canal be not altogether inappropriate on this occasion, surrounded as we are by this great Exposition, whose purpose it is to celebrate the opening of that waterway.

Meeting in San Francisco, the people of which are desirous of welcoming the members of the Congress within its limits, I take pleasure in first introducing to you its representative, the Honorable James Rolph, Jr., Mayor of the City. (Applause.)

Mayor Rolph.—Mr. Chairman, Honorary President of the Engineering Congress, our distinguished members and guests, members of the convention, ladies and gentlemen: I know of no convention, that I have had the honor to address and to welcome in the name of my fellow-citizens of San Francisco, that has appealed to me more than has the convention which I have the honor this morning to address. I am here as the

Mayor of the great City of San Francisco to extend a welcome to the International Congress of Engineers, who honor our city by coming from every corner of the world to hold their convention in this city by the Golden Gate. I join with the world in paying a well-merited tribute of admiration to the distinguished American, to the distinguished international character, to the man who has divided North America from South America, who has joined the waters of the Atlantic with the waters of the Pacific and opened up a great highway to the commerce of the world, the man who presides over this Congress, Major-General George W. Goethals, His Excellency, the Governor of the Panama Canal Zone. (Applause.) Our city feels that it is the greatest beneficiary of this wonderful waterway. We realize that the completion of that undertaking has brought our city before the eyes of the world and has made her today, we think, one of the leading cities of the world; leading,—yes, the city that lay in ashes only a few years ago, the city we present today, built up by the energy, by the enterprise, by the enthusiasm, by the constructive genius of the splendid body of American citizens that comprise our city of San Francisco. And we feel that we have been accorded the prize in celebrating, with Major-General Goethals, the completion of the Panama Canal, which promises to do so much for our Pacific Coast, and particularly for San Francisco. We are pleased that engineers from all over the world are meeting here within the city of San Francisco and that they will have the opportunity of seeing at first hand evidences of the masterful brain, of the keen intellect and untiring study of those members of the engineering profession to whom today we pay a tribute of gratitude for the work that has given to San Francisco the opportunity of rising up and becoming one of the peerless cities of the United States. I wish to call your attention, gentlemen of the engineering profession, to a few of the accomplishments, in an engineering way, in this, our city. We think that San Francisco, while she had a wonderful past, has a still more brilliant present and still more promising future.

We have established here, in order that our city may never be destroyed again by conflagration, an auxiliary fire-protection system,—a system completed at a cost of 5,750,000

dollars, to carry the waters through the mains throughout this city, and which will prevent forever such an experience as the total destruction of San Francisco by fire. We have also built through and under our streets a wonderful sewer system, costing 6,150,000 dollars. Our streets were gone, our pavements were destroyed, yet you will see what has been accomplished in the way of new streets, new pavements and new curbs, at a cost of 8,000,000 dollars. We have pierced some of our hills; we have put through the Stockton Street Tunnel, costing 650,000 dollars and we are building under the sight of beauty, Twin Peaks, a tunnel 12,000 feet long, which will be completed in 1917, costing the sum of 4,000,000 dollars. We are developing in the high hills, two hundred miles from here, one of the greatest systems for water storage that any city can boast, and which, when completed, will cost 45,000,000 dollars. This great system will supply water and hydro-electric power, not only to this city, but to all the cities around the Bay for generations to come. San Francisco has also gone into the business of municipal railways, owning and operating municipal lines along many of the principal streets of our city; along Van Ness Avenue, which carries most of the visitors to the Exposition. We intend to develop still more this business in the great city of San Francisco, by building these lines into the outlying districts. We are seated here today in the Municipal Auditorium, built at a cost of 1,250,000 dollars; and yonder they point with pride to San Francisco's magnificent City Hall, a building which typifies the artistic taste and character of my fellow-citizens of San Francisco; and as you look at that building, you will see the dome which towers thirty-eight feet higher than the dome of the Capitol at Washington, D. C. This building was started and finished in three and a half years' time. This indicates the character of the people of this city, and I am here this morning to extend to you a hearty San Francisco welcome. That welcome comes from the earliest San Franciscans; it comes from the early Padres and from the old Spanish pioneers who settled in this city in 1776. Those early pioneers are evidenced by the Mission Dolores and by the old landmarks of this city which are still standing. That welcome comes down, through these 150 years, from the earliest civilization of San Francisco, from those old pioneers, from

those before the fire, from those after the fire, down to the present time. The motto over the home of every San Franciscan, the motto of welcome I give to you this morning, is, "Our hearts, our homes, all that we have is yours", and I pay San Francisco's tribute to you, to the men who have done so much, and who will continue to do so much to build up this great country of ours, and particularly to Major-General George W. Goethals. (Applause.)

President Goethals.—When the Panama Canal reached such a state as to give some hope of completion, the people of the United States began to consider the advisability of celebrating its opening by an international exposition, and San Francisco was awarded the prize. San Francisco, I believe, is the only city that could have gotten the prize, because it means more to this Coast—that is, the canal—than to any other part of the country. San Francisco took up its task with characteristic energy and enthusiasm, and here again the engineers have come to the front and have taken their share in the construction of this great Exposition, in the laying out of the buildings and in its magnificent system of lighting. All enterprises need a head, and San Francisco was not lacking in the necessary executive and administrative ability. They were found concentrated in the man who is now the President of the Panama-Pacific International Exposition, and it is my pleasure to introduce him to you,—Mr. Charles C. Moore. (Applause.)

Mr. Charles C. Moore.—Ladies and gentlemen: I have played many roles in this Exposition since the day, six years ago, when we started our work, but the role this morning, of messenger to you, is one that really gives me genuine pleasure.

The message I bring is from the Exposition, a message of good-will, of interest and of great expectations as to the outcome of your deliberations and your labors. We have secured from the beginning over 880 congresses and conventions, and we feel that, by right, this Congress belongs at the head of the list.

Friends, there is little that I can say to you. You will ascertain outside these walls the earnestness and the genuine feeling with which you are received; you will learn outside of these walls, the nature of our work in San Francisco, and

you will draw your own conclusions as to whether we have properly represented you. But I wish you to bear in mind that through the years of preparation for the Exposition, we have earnestly striven to advance humanity in all its activities —not only in architecture, the fine arts and the sciences, pure and applied, but on the fraternal side as well. And therefore I trust that the results of your work here may go into history, with a record which shall be instinct with the life of what we believe is the vitally potential influence that the Exposition as a whole is going to exert on the future. Therefore, please remember that we of the Exposition take a vital interest in what will be done in this Congress. Also a thought comes to me that today in many parts of Europe, on the battlefield and in the trenches, there are men undoubtedly who are thinking of us here, men who would have been here had conditions been right. And, therefore, I think that those who are fortunate enough to be here should realize that they represent those who are thinking of us, but who cannot be with us.

I therefore hope that your deliberations will be successful; that new friendships will be made, most pleasant, beneficial and lasting.

Speaking for the Exposition, you are one of the very brightest jewels in our whole galaxy. We are glad you are here. You have a great amount of work to do, as the Chairman has intimated, and God speed you, and good luck to you. (Applause.)

President Goethals.—Gentlemen: Other international expositions have been held in the United States, but in each instance their inspiration was found in some past deed, or event of much moment to our country, in each case the memory of living men formed no part. We celebrated in this way the anniversaries of the Declaration of Independence, the Discovery of America, and the Louisiana Purchase. Here is the first exposition to celebrate a contemporaneous event. Even so, it is at the same time the culmination or outcome of Christopher Columbus' search for that narrow strait connecting the two great oceans; and there are many now living, in this and other lands, who participated in bringing to a reality the dream of centuries and take pride in the part they took in accomplishing it. While other expositions had portrayed the advances in all branches of

industry since the event they celebrated, the benefits that will result from the Panama Canal must be left for time to disclose.

While advantage was taken of various expositions to gather together in so-called congresses various organizations, including the different engineering societies, this is the first time, if memory serves me correctly, when the great engineering bodies of the country have united in an international congress. It is peculiarly fitting that such a combination should be formed for this exposition, for the object celebrated is the accomplishment of the engineer, using the designation in its broadest sense; since in the construction of the Canal practically every branch of the engineering profession can find some part which belongs to its particular sphere. The engineers employed under the authorities charged with the construction of the Canal and engaged directly with it are not the only ones included in the grouping, for in the design of the various machines, appliances and plant of all kinds, the skill, ability, and ingenuity of other engineers were engaged whose names do not, and unfortunately never will, find association with the work, yet who materially assisted in the accomplishment of the enterprise. In fact, considering this phase of the situation, the applied scientist in many lines of endeavor must be included.

In its inception and execution, the Canal is an international work, first hoped for in the form of a strait by an Italian navigator sailing under letters patent from the King of Spain. Later, when all hope of the existence of such a waterway was abandoned, the construction of such a passage was conceived by a Spanish engineer. It was attempted later by Spain, France, Portugal and England, but reserved for the United States to bring it into being, thus fulfilling Goethe's prophecy. In doing it, however, engineers of various countries were engaged, while the actual construction force was made up of citizens from all parts of the world.

For the papers prepared on the Panama Canal for the proceedings of this Congress, an effort was made to present the various engineering features of the work; and as these are to be discussed during the session, their repetition here is neither necessary nor desirable. There are some matters connected with the enterprise, however, which do not appear in the

papers, and which I feel properly belong to this phase of the proceedings.

We are so much taken up with the present and future that we are apt to overlook the work done by those who were not fortunate enough to be in the fore-ranks at the completion of the Canal, but whose work nevertheless played an important part in the final success, resulting, as is usual in such cases, in undue credit to those who are in at the death. While it is true that time alone must be relied upon to bring a proper perspective, it cannot be amiss for me to bear testimony to the efforts and achievements of those who were responsible for the foundations of the structure, which were prepared with such thoroughness as to insure the consummation of the project.

The Panama Railroad was the first connecting link between the two oceans, and the difficulties that were overcome in its construction by the forces under George M. Totten seem in the retrospect, considering the appliances available at that time, the diseases that were prevalent, and the difficulties attending the procurement of labor, to have been greater than those subsequently encountered in connection with the Canal. The railroad, through its concession, had exclusive control of all means or methods of communication across the Isthmus, so that the French Company organized to construct the Canal first secured permission from the railroad company to proceed with the digging of the Canal, and subsequently found it necessary to purchase the controlling interest of the company. The railroad was a necessity in prosecuting the Canal work. It was built with American capital and by American engineers, who carried the project through after it had been attempted and given up by engineers from other countries, with the characteristic energy and perseverance that make the American pioneer.

The French Company was the pioneer in the Isthmian Canal work. It failed, not because of its engineering difficulties or faulty methods; its engineering work deserves nothing but praise, and the more one studies what was accomplished, the greater admiration is felt for the men in charge on the Isthmus, and there comes a sense of regret that success did not crown their efforts. The failure was due to mal-administration. It has been attributed to lack of sanitation, but this can

hardly be the cause, since new men undauntedly took the places of those who fell by the wayside and carried on the work until the available funds were exhausted. The United States is greatly indebted to both the first and second companies, for they had paved the way. We benefited by their experiences, and by what they left to us in the way of surveys, machine shops, equipment, lands, quarters, and work accomplished. The purchase price paid to the second company was reasonable and we received full measure for our outlay.

Furthermore, the United States entered upon the task under more favorable auspices and conditions due to the advances in preventive medicines, in engineering knowledge, and in constructive material of all kinds and description. Again, we secured rights and privileges through treaty stipulations which a private corporation or company could not secure, which were of immense advantage in doing the work.

The war with Spain brought prominently to the front the necessity for a Canal, through the voyage of the "Oregon" from the west coast to the east; and one of the great results of the war was the discovery of the cause of yellow fever. The theory that yellow fever is transmitted by the stegomyia mosquito had been advanced by Dr. Carlos Finlay, an American physician residing in Cuba; and in 1900, during the American occupation of Cuba, when yellow fever became epidemic in Havana, a board was appointed to continue the study of the disease. The members of that board were Drs. Walter Reed, James Carroll, Aristides Agramonte (a Cuban immune), and Jesse W. Lazear, who, assisted by volunteers from the Army, demonstrated the truth of Dr. Finlay's theory by offering their lives as willing sacrifices to the cause of humanity; and they formulated rules which, when put into effect in Havana and vicinity by Colonel Gorgas, rid this locality of that dreaded scourge. A similar result was secured subsequently on the Isthmus. Sir Ronald Ross, of the British Army, had proved also that malaria was due to the Anopheles mosquito, and had rid certain sections of Egypt and India of this disease. We had the benefit of his experience and counsel with respect to the Isthmus. These two important discoveries gave the means of eradicating or lessening the effects of the diseases and led Colonel Gorgas, by the application of the preventive prescrip-

tions formulated by these men, to change the Isthmus from a pest hole to a reasonably healthful locality.

When Congress authorized the President to construct a Canal and after the treaty with Panama was ratified, a Commission was appointed by the President consisting of Admiral J. G. Walker, Major-General G. W. Davis, W. B. Parsons, William H. Burr, Benjamin M. Harrod, Carl E. Grunsky, and Frank J. Hecker.

Mr. John F. Wallace was appointed Chief Engineer. Steps were undertaken to do for the Isthmus what had been done in Havana and elsewhere, ridding it of the ravages of yellow fever and reducing malaria. The Commission was designated by the President as the legislative body for the Canal Zone and it established a government that continued in effect until the Panama Canal Act was made effective. Such changes and modifications were made during the construction period as circumstances or conditions indicated to be necessary or desirable.

In addition to the establishment of a system of government for the Canal Zone, and such preparatory work as was undertaken with a view to forwarding the enterprise, I regard the fixing of the delimitations of the Canal Zone as the most important accomplishment of the Walker Commission, and for this credit is due in larger measure to General George W. Davis than to any one else. The treaty with Panama provided for granting to the United States a ten-mile strip across the Isthmus, exclusive of the cities of Panama and Colon and their adjacent harbors. Imports to Panama arriving on the Pacific side were landed at La Boca, which was part of the harbor of Panama, and on the Atlantic side the entire bay was readily conceived as the harbor of Colon. General Davis saw the possibility of a Canal the entrances to which were under the control and jurisdiction of a foreign power, and he at once took the necessary steps so to fix the limits of the concession as to secure to the United States the control and jurisdiction of all portions of the route connecting the waters of the two oceans. Though difficulties were experienced, a preliminary agreement was finally drawn between himself and the Secretary of Foreign Affairs of the Republic of Panama and certain concessions were subsequently made in the form of revenues

to the Republic, which resulted in a recognition of this agreement by the Republic of Panama. It was not, however, until 1914 that the delimitations then fixed regarding the terminals were finally adopted in the form of a treaty ratified by the two republics concerned.

Mr. Wallace foresaw the necessity of substituting the heaviest equipment possible for the work of excavation, inaugurated the system of recruiting labor, and the policy of making the working force comfortable by providing suitable quarters for their accommodation. The Walker Commission was replaced after the adjournment of Congress in 1905 by the Shonts Commission. This Commission consisted of Theodore P. Shonts, Chairman, Charles E. Magoon, John F. Wallace, M. T. Endicott, P. C. Hains, O. H. Ernst, and B. M. Harrod. Mr. Wallace resigned June 28, 1905, and was succeeded by Mr. John F. Stevens, as Chief Engineer and member of the Isthmian Canal Commission, on July 1, 1905. Governor Magoon, who continued in the service until October 12, 1906, and Mr. Stevens were the sole representatives of the Commission on the Isthmus, and Mr. Stevens, subsequent to the transfer of Governor Magoon to Cuba, was the only member of the Commission on the Canal Zone. He was in charge of all construction work until April 1, 1907. The vast amount of preliminary work that was accomplished prior to this date seems almost incredible, and can be appreciated only by those who are familiar with the conditions as they existed; to these two men, John F. Wallace and John F. Stevens, is due the credit for so laying the foundations as to secure the results which were subsequently attained. In considering the work done during the preliminary stage, we must associate with it the name of Jackson Smith, who inaugurated the system of subsistence, the establishment of rules for quarters, and perfected the arrangement for the recruitment of labor; Bierd, the Manager of the Panama Railroad; Tubby, the organizer of the depots for construction supplies, their requisition and issue; Brooke, who rehabilitated the machine shops and arranged for the assembling and erection of the various machines and the facilities for their repair; Maltby, Dauchy, Sullivan, Bolich, Rourke, and Nichols, engineers in charge of various parts of the work; Ralph Budd, Chief Engineer of the Panama Railroad, in charge of its main-

tenance, and subsequently of the construction of the relocated Panama Railroad, which was finished by Mears on the resignation of Mr. Budd to enter engineering work elsewhere.

When the so-called Army Commission took charge in 1907, the Isthmus had been freed from yellow fever by Colonel Gorgas and the men under him, a vast amount of preliminary work was completed, and a stage was reached when the dirt could be made to fly. Mr. Stevens hoped to reach the million mark the last month of his administration, and it was unfortunate that he missed it by a few thousand yards, since he seemed so desirous of attaining that amount. He had established an organization for the handling of the work through the continental divide (then known as Culebra Cut, now Gaillard Cut, in honor of the man associated for over seven years with this part of the work), which was continued practically throughout the period of dry excavation. He is an expert in railroad transportation and perfected a system which would have been impossible for us unless the services of such an expert could have been secured. He began the excavation for the Gatun locks, cleared the sites for the various dams, and had made preparations for the construction of the latter on the Pacific side. As the lock type of canal was not adopted by Congress until June, 1906, a designing force for the locks, dams, spillways, and their operating machinery was organized, but little had been done in connection with the designs themselves.

The general scheme of the organization as it existed at the time of the transfer of the work on April 1, 1907, was continued, changed only in such respects as were necessary to make it conform to the new order of things, which required all members of the Commission to reside on the Isthmus; to give them equal consideration, each was placed in charge of a department of the work. With three departments, constituting the Department of Construction and Engineering, with the natural desire of each head to make his department the most important, it is easy to see that friction was inevitable. The great difficulty was in the organic law which provided an executive head of seven; but as a change in the law could not be secured, the difficulty was overcome by means of an Executive Order. In other respects, also, it was found that the or-

ganization did not work satisfactorily; there were too many subdivisions, each independent of the others, and, with their work overlapping, it was difficult to secure harmony and proper co-operation, as well as impossible to determine and fix responsibility. Consequently, in 1908, after more than a year's experience, it was decided to make a change, which was put into effect on July 1, 1908. The fundamental idea of the reorganization was to bring about such a subdivision of the work as to definitely fix responsibility; subsequently, to encourage each sub-head to use such means as he deemed proper in the accomplishment of definite results, these being more desirable than the means for securing them, thereby bringing out individual initiation and holding every one to account for getting the ends sought.

This led to the creation of three territorial divisions; one embracing all the work from deep water in the Caribbean to and including the dam at Gatun; another, all work from the locks and dam at Pedro Miguel to deep water in the Pacific; and the central section, between Pedro Miguel locks and Gatun locks. To each was assigned a Division Engineer, and all construction work, no matter what its character, within the territorial limitations of the division, was placed under the division head. The work of each division was so divided that there was no difficulty at any time to fix responsibility, and whatever friction might result could be easily handled and settled.

The best results can be secured if there is an honest rivalry between different portions of the work, and the terminal divisions lent themselves admirably to this; the work of these two divisions was of the same character throughout—the construction of locks, dams, dry excavation and dredging; the Atlantic Division was placed under Army engineers and the Pacific Division under civilians. In the Central Division, where the work was principally excavation, not comparable with the digging done in the terminal divisions, a rivalry was started between the steam shovels, the crew of each striving for the best record per week or month, in order that they might secure note of the fact in The Canal Record.

I believe that we had the finest organization that could be created for any piece of work and with an *esprit de corps*

that has never been surpassed; each man was imbued with the idea that his particular piece or task was the one that was necessary to make the Canal a success; and this spirit continued until after the water was turned into the Cut in 1913. When the working forces began to realize that the end was in sight, their desire to continue on the Government pay roll as long as possible made it up-hill work to arouse any enthusiasm outside of the dredging division, or to hasten forward the completion of the work.

In the organization that continued on through to its final breaking up, I am particularly indebted to Colonel H. F. Hodges and Mr. H. H. Rousseau. The former had charge of designing the locks, and the spillways, with their appurtenances, and carried them to completion. He was assisted in this work by Mr. Henry Goldmark, who designed the gates and had supervision of their construction under contract; by Edward Schildhauer, who is responsible for the electrical installation, the method of operating the lock gates and the valves, and who, in combination with the engineers of the General Electric Company, evolved the control board; by Lorenzo D. Cornish, H. F. Tucker, and T. E. L. Lipsey, who assisted in designing the locks, valves, and other details; and by Edward C. Sherman, whose plans for the spillway were adopted. Mr. H. H. Rousseau, Civil Engineer of the Navy, had direct charge of the terminals, dry dock, coaling stations and docks, certain mechanical features of the work, and assisted in estimates and kindred questions. He and Colonel Hodges were my principal advisers. No action was taken on any matter of importance except after consultation with them, and although we did not always agree on the action to be taken, they were thoroughly loyal in every respect.

Colonel W. L. Sibert was placed in charge as Division Engineer of the Atlantic Division, and assisting him were Colonel Chester Harding, Assistant Division Engineer, who, prior to the reorganization, was in direct charge of the Gatun locks, subsequently in charge of the office work, and then of the construction of the West Breakwater and dredging in the Atlantic Division. Major James P. Jervey was directly in charge of lock construction under the reorganization scheme; Major G. M. Hoffman, in charge of the dam and the construction of the Spillway; Major H. V. Stickle in charge of the Porto Bello

Quarry and of procuring sand from Nombre de Dios; and Major Edgar Jadwin, during his stay, of the breakwater and dredging work.

The work on the Pacific side was placed in charge of Mr. S. B. Williamson, Division Engineer, and with him were associated Mr. J. M. G. Watt, as Assistant Division Engineer; Wm. B. Corse, Gratz B. Stickler, H. O. Cole, R. B. Tinsley, and H. D. Hinman, stand out prominently among those who were employed on lock construction; Mr. Comber was in charge of dredging. Mr. Williamson had been associated with me in other work in the United States, and I do not believe there is a man with whom I have had more differences over technical points, but like Colonel Hodges and Mr. Rousseau, no matter what decision, whether for him or against him, he always lent loyal support to make a success along the lines of the decision.

Of the Central Division, Colonel D. D. Gaillard was the Division Engineer, with Mr. L. K. Rourke, Assistant Division Engineer, and Mr. A. S. Zinn as Office Engineer. When the organization was put into effect in 1908, the general charge of the office and the field work was assigned to the Division Engineer and Assistant Division Engineer, the former making such disposition of the work as he saw fit. Colonel Gaillard preferred the general office work, placing the Assistant Engineer, Mr. L. K. Rourke, directly in charge of the field work, and this arrangement continued until the resignation of Mr. Rourke on July 11, 1910, when Colonel Gaillard exercised control over the field work, assisted by A. S. Zinn, and for a time a General Superintendent, G. A. Greenslade. His District Superintendents were J. W. Little, J. M. Hagan, M. W. Tenny, W. T. Reynolds, and J. M. Sneed.

When a reorganization was made in 1913, due to a drawing to a close of the work in the various divisions, W. G. Comber was placed in charge of all the dredging work on the Isthmus, assisted by J. MacFarlane, and is now handling the excavation that is made necessary by reason of the slides.

In an organization so large as that employed in the work on the Isthmus, it is not possible to give the list of all on the rolls; and even of those engaged on engineering work, to which I am limiting my references, the names of the more prominent ones only are mentioned; but all who shared in the undertak-

ing should receive each his due share of credit, for it was not the work of any one man or set of men, but of the combined efforts of all.

In 1902 Congress authorized a bond issue in the amount of $40,000,000, based on the estimate submitted by the Isthmian Canal Commission in its report of 1899-1901, for the construction of the Panama Canal in accordance with the plans presented. The Canal contemplated a lock type with a dam across the Chagres Valley at Bohio, which was modified by the International Board of Engineers in the report submitted by them in 1906, and the cost of which, exclusive of sanitation and civil administration, based on practically the same unit prices as the estimates of the 1899-1901 report, was $139,705,200. Changes were made in the project which Congress adopted in June, 1906, consisting of the withdrawal of the locks on the Pacific side and of widening that portion of the Canal through the continental divide. The locks were also increased in size.

Among the criticisms raised against the lock type of canal was one which asserted that the locks would be too small for the Navy of the future, so I took up the matter with the President of the United States, with a view to securing an expression of opinion from the Navy Department as to the size that should be adopted to provide for future developments of naval vessels, submitting an estimate of the additional cost that would result for increases of width for each five feet up to 125 feet. The General Board of the Navy reported that locks of 1,000 feet usable length and 110 feet in width would be ample for future naval needs, and the dimensions of the locks were fixed accordingly.

By 1907 the expenditures were rapidly reaching the amount of the authorized bond issue, so that it was necessary to revise the estimates and submit to Congress the additional amount that would be required. In making the revision it was decided to include all amounts that had been appropriated, such as the $40,000,000 paid the French Company, $10,000,000 paid the Republic of Panama for the concession and rights conferred by the treaty, the monies that had been advanced to the Panama Railroad for its equipment and practical rebuilding, and the cost of sanitation and civil administration, estimates for all of which items had been omitted from the estimate pre-

pared by the Board in 1906. The result of the revision was that the new estimate, including all items, aggregated $375,200,900. In this connection, it must be remembered that our overhead expenses were out of all proportion to those of similar enterprises because of the paternal interest we took in our employees, providing them with free quarters, lights, fuel, and furniture, free medical attendance in hospitals, and other considerations which materially increased the costs.

I believe that Mr. Wallace made an attempt to establish a system of cost-keeping, but how far it advanced I do not know; at any rate, there was no such system extant when we assumed charge. We knew that the work of excavation in the Culebra Division, which was in progress, resulted in the removal of a certain number of cubic yards as the case might be, and that a certain sum had been expended; it was assumed, therefore, that the costs were one divided by the other. There was no means of checking the leaks, and it soon became apparent that some system must be devised by which we could determine the cost of the work, in order to ascertain if we were securing the results in accordance with the estimates. The cost-keeping system introduced was carried forward to the end, with very beneficial results. Some of the officials objected at first on the ground that we were there to build a Canal and not to set up a kindergarten for accountants; they soon realized from the records of costs the necessity for reducing theirs, and that the accountants of the kindergarten were securing results.

In the excavation of the Gaillard Cut our greatest difficulty is due to slides. They are not discussed here, because they properly belong for description and discussion in another part of the proceedings of this Congress, but they are the only unexpected feature which would tend to increase the costs.

In 1910 it became evident that, based on the estimates of 1908, we would be able to build the Canal well within the sum specified, and we submitted to Congress the proposition of constructing certain terminal facilities as desirable, if not essential, adjuncts, all of which, from data available at that time, could be constructed without exceeding the amount of the authorized bond issue. The Navy Department was desirous of having a dry dock capable of taking in the largest battleships, and also considered desirable were coaling facilities,

machine shops to perform any class of work they might be called upon to do for shipping, commercial or naval, and certain docks for the handling of cargo at the Pacific entrance—the Panama Railroad undertaking the construction of similar docks on the Atlantic side. These were authorized by Congress in 1912, and the total amount to be expended for this additional work is $20,550,000. So that, under the estimates not only will the Canal be built, but these terminal facilities with their appliances not originally contemplated, as well as a new settlement near the Pacific entrance, which has been started and is well advanced toward completion.

The Canal is another illustration of the functions of the engineer, his uses of the forces and materials of nature for the benefit of man; it is another instance of the fact that engineers are fitted for great executive and administrative functions, and also that they can establish and manage a government to the satisfaction of those governed. Believing in straight-forward, practical administration, as the engineer does, such a government to be successful must not be political, but autocratic, for with politics involved there would enter an unfamiliar factor opposed to the engineer's training and ideals, and he would fail.

We were fortunate, as far as the Canal was concerned, in having it inaugurated by a President whose sole desire was to get the work done, and with the exception of one position on the Commission, he took the stand that politics should have nothing whatever to do with the Canal nor interfere in any way with its prosecution. He also recognized the fact that a seven-headed executive was impotent, and when Congress would not amend the law, he issued an Executive Order which accomplished the result desired, irrespective of the law. The policy thus inaugurated was carried out by both of his successors and has had much to do with the results secured.

As the construction period drew to a close, it was necessary to prepare for the operation and maintenance of the Canal, and to secure such legislation as would permit this in the simplest and most businesslike way. With the adoption of the policy that the Canal Zone be depopulated and used exclusively for the operation, maintenance, protection, and sanitation of the Canal, and such other governmental functions as might be

needed, the question of the government to be established was very much simplified, and the duties in connection with it, its operation and maintenance, are essentially the function of an engineer. Fortunately the law provided for the same concentration of authority in the hands of one as had been established by the Executive Order of 1908, but the executive authority was placed in the hands of a "Governor". The selection of this term was not altogether fortunate, but it was impossible to secure any modification in the bill which was presented to Congress for its consideration, and, as the measure was enacted, this title was adopted. When the reorganization was under consideration, a committee of my colleagues drew up a report on the reorganization which should be adopted, and strange to relate, though two of them were engineers, their scheme contemplated the appointment of a Governor, not necessarily an engineer, and a Chief Engineer subordinated to the Governor. This I opposed, as with the Zone depopulated, the military not under the control of the Governor, and no residents other than Canal employees to be looked after, there was very little to govern, and it seemed to me that it would be rather galling for the Chief Engineer, having the bulk of the work in his charge, to be subordinated to a man who knew nothing about it, and who would have relatively little to do. The outcome has been that an engineer, even though he belongs to the Army, was made Governor of the Canal, and I am now hoping that my successor will be an engineer and that an engineer will always be in control.

I appreciate your attention, and while I have no doubt there are a number of features connected with the work concerning which you would like information, they may properly belong for explanation and discussion to the meetings provided for during the other sessions as prescribed by the program. As I am unable to be here during the entire congress, our Chairman has arranged that the subjects relating to the Canal will be considered prior to my departure, so that I hope to be able to give any additional information concerning the enterprise that may be desired.

It is now my pleasure to introduce to you Major Jean L. de Pulligny, the representative of the French Government, who was located in the trenches at the time he received his orders

to proceed to this Congress as the representative of his Government, and it is an honor to present him to you. (Applause.)

Vice-President de Pulligny.—Honorary President, members of the Convention, ladies and gentlemen: It is quite an unmerited honor for me to be here today, being the only vice-president from the Continent, and to represent before this impressive Congress my dear country, France, sweet France, the France of Rochambeau and La Fayette, the France of a brilliant past and of an enduring future.

Gentlemen, you must not fear that I shall make a long speech, for I have just been getting quite a training in this regard. You certainly know that my dear country has been very busy for these last fourteen months. Well, I have been busy too, and in the same business; and in that business, deeds are the only things that count; and as for writing or speaking, the rule is what old Caesar used to call *"Militaris Brevitas"*.

But I must not go further, gentlemen. There are some matters which must not be spoken of before an international audience. I have better to do and better to say.

If I have been rushed from the front on what I might call a life-belt sea trip, and then brought through the continent of America, it is not to speak of what is being done on the other side of the pond. It is to celebrate the gigantic and peaceful achievements which have been accomplished here, and it is especially gratifying for a French engineer, and for a sincere friend of America, to praise the admirable, the wonderful, the nearly superhuman work which your brilliant Exposition commemorates; for it is my own dear country which had the daring boldness to undertake this gigantic enterprise of world-wide utility.

It will be the everlasting glory of America, through the centuries of the future, that she had the pluck; that she had the nerve; that she had the immense wealth; that she had the men, and that she had the man who was necessary. (Great applause.)

That man—I am nearly ashamed to sit by his side, and I scarcely dare to praise him, that man who has achieved this enormous work, feeling that I am only an ordinary commonplace government engineer, who had scarcely to spend a few

millions on the work entrusted to him. What is this compared to the man of genius who had to be a statesman as well as an engineer, who communicated his inflamed impulse to an army of men working under him, who had to overcome a world of difficulties and who had to spend millions, hundreds of millions for digging the most splendid and useful ditch in the world?

Gentlemen, I have come over here to carry to you the greetings of the people of France, and of her government.

Long life and every success to the Panama Canal—long life and every success to San Francisco and to the Exposition —long life and every success to America. (Great applause.)

President Goethals.—We have with us today a delegate from Canada, Mr. J. B. Challies, and I take pleasure in introducing him to you. (Applause.)

Mr. Challies.—Mr. Chairman, members of this Congress, ladies and gentlemen: It is a great privilege to be here at this Congress as a representative of the Government of the Dominion of Canada and of the Canadian Society of Civil Engineers. Such a congress as this is an inspiring evidence that international engineers are called to meet and exchange ideas to further the arts of peace and humanity and of commerce. This Congress should result in drawing nations together, more particularly those on the North American continent. It will cement, as the Exposition has already done, the ties of friendship between the people of the United States and Canada.

As the engineer is ever the advance-guard of civilization, such a congress as this is of inestimable value; and Canadian engineers are indeed proud and pleased to be present to participate in its privileges, not only to pay tribute to the greatest achievement of American engineering genius, but to hold out our hands in fellowship to brother engineers of all countries, as loyal workers in the cause of mankind.

Like many other countries, Canada's participation in this Congress has been unfortunately and unavoidably curtailed. Notwithstanding her international responsibilities, however, the Canadian Government has taken an active interest in this Exposition and has endeavored to show within the Canadian Pavilion her boundless natural resources and her wonderful achievements in agricultural and industrial development.

Canadian and American engineers may be pardoned for pointing out that there is no international boundary in engineering activities in North America, and that the boundaries of the two countries are fixed by nothing more than an imaginary line. There are no fortresses guarding our frontiers and no warships patrolling our boundary waters. On the contrary, strategic points along our international boundary from the Atlantic to the Pacific are almost invariably marked by important hydro-electric power plants which form the pulse of great commercial and industrial districts. The inventive genius, the constructive capacity and the executive ability of the engineering profession of our two countries has, therefore, not been confined to works of defense and offense along our three thousand miles of boundary, but has been concentrated in furthering, in a cooperative way, international industry, commerce and civilization. May it ever be so.

We engineers of the United States and Canada have a tremendous burden upon our shoulders. We must continue to demonstrate to the world at large, as we have demonstrated for over one hundred years, that all our international differences, be they what they may, can be adjusted in a peaceable, businesslike and honorable manner.

Out of this hundred years of international unity, good will and friendship, has grown probably the most unique permanent court in the history of the world, and one of most unusual moment to the engineers of both countries—the International Joint Commission, created about five years ago by treaty between the United States and Great Britain. This court comprises three American and three Canadian citizens, and was created for the one purpose of investigating and facilitating a settlement of all matters of difference respecting boundary waters.

I wish I had powers of speech beyond mere matters of fact, because while this occasion is not so dramatic as certain current events, yet I profoundly believe that after this wonderful collection of art and architecture, called the Exposition, has disappeared and there is little left but an abiding memory of the splendor and beauty of the scene, the spirit of this great Congress will remain as an ever-potent influence for the advance-

ment of engineering throughout the world. A few years hence the people of this, the Golden City of California, will have reason to remember with pride that this International Engineering Congress took place in their midst, as a fitting culmination of the celebration of the successful accomplishment of one of the world's most momentous engineering feats—the joining of the Pacific and Atlantic Oceans by the Panama Canal.

Canadian engineers give place to none in admiration of and in paying tribute to the indomitable courage, the tremendous capacity and skill of the American engineers, headed by General Goethals, who are responsible for the successful completion of this gigantic undertaking. (Applause.)

President Goethals.—We have with us a delegate from Cuba, and I take pleasure in introducing him to you,—Señor J. R. Villalon y Sanchez. (Applause.)

Señor Villalon.—Mr. President, General Goethals, gentlemen: I accept this applause as an expression of the good feeling and friendship that the United States entertains for Cuba, and I wish to say that we fully reciprocate that feeling. (Applause.) Cuba reciprocates, and does more than that, she feels friendship and gratitude towards the United States, and we want to avail ourselves of every possible opportunity to express it and to dispel any possible idea to the contrary on the part of anybody.

I am not going to take your time to make a speech, because the hour is passing and others will have to speak; and after the speeches of the distinguished gentlemen who have preceded me, I cannot see my way to do it. But I do want to say on behalf of the Republic of Cuba that we appreciate greatly the honor that the Government of the United States has placed upon us by inviting us to participate in this great engineering congress on this occasion. At the same time, I beg to extend our gratitude and appreciation to the International Engineering Congress on behalf of our local society of engineers.

It is said that, "Imitation is the sincerest flattery", and I desire to say, the Cuban Government has granted leave to all engineers employed in Government work to come over to this country for the purpose of observing, of studying, and of assimilating everything that is broad and noble in this country, and

to bring it back with them, to give Cuba the benefit of their visit on this occasion.

I want to thank you, gentlemen, for the invitation, on behalf of the Government of Cuba, and on behalf of the Local Society of Engineers of Cuba. (Applause.)

President Goethals.—China is represented here by its delegate, an admiral of the Chinese Navy, and I take pleasure in introducing him to you,—Admiral Wei Han. (Applause.)

Admiral Wei Han.—Mr. Chairman, members of the Congress: As one of the four delegates appointed by our Government, I deem it a very great honor and privilege to convey to you the message of greetings and sentiments for this worthy assembly.

I recollect in 1873, when I first passed through the Suez Canal, which was just completed, I admired very much such an achievement and success. In Paris, I made the acquaintance of M. Ferdinand de Lesseps, builder of the Suez Canal. He was just preparing the enterprise of opening another canal through Panama Isthmus. However, being confronted with a number of difficulties, he failed. Today we are gathered in this city for the celebration of the opening of the Panama Canal. Although I could not avail myself of the opportunity to see the actual work of the newly opened canal, yet I am fortunate to be with the men who have made successful their efforts to overcome such difficulties which defeated M. de Lesseps.

In conclusion, I wish to congratulate the American engineers for this marvelous engineering work, as well as our Honorable Major-General George W. Goethals. I thank you. (Applause.)

President Goethals.—Señor Don Fernando Cruz, of Guatemala, is here as a delegate from his country, and I am pleased to present him to you. (Applause.)

Señor Cruz.—On behalf of my country, the Republic of Guatemala, and her President, Manuel Estrada Cabrera, who bestowed upon me the honor of being her unworthy representative to this International Engineering Congress, I heartily congratulate all of the engineers of the world here gathered, believing that from the work accomplished by this illustrious universal assembly of scientific men cannot be expected but wonderful improvements for the better conditions of mankind.

I easily realize how insignificant I am among all these celebrated personalities who have as their pedestal some great work fulfilled in some of the world's activities; but, anyhow, I will do my best to bring my grains of sand to this great scientific congress.

The Republic of Guatemala is situated in the central part of this vast and beautiful continent of America; it is the hyphen that unites the other two bigger portions of the Western Hemisphere. It has become, by the completion of the Panama Canal, the most striking feature ever recorded by history, the center of the world, the forced thoroughfare of all travelers roaming through continents and oceans. Its geographic position between the two halves of our hemisphere and two largest oceans that bathe its shores, its immense and little developed resources, leads us to think and even to be convinced that in the near future it will be one of the richest and most prosperous regions on earth.

Actually, Guatemala can be regarded as essentially devoted to agriculture; but I beg to state that the Government, understanding the necessity of developing the mineral resources and industries of the country, has legislated anew on these matters and made very liberal laws.

The new Mining Code was promulgated by the present Government in 1908 and since then we have seen the number of mining claims increase in a very rapid ratio; some of the mines have been since then exploited, and today we are beginning to export zinc ore as well as gold to the United States.

During the colonial epoch, many mines were patented, among them lead and silver ore existing in the northern part of the Republic and were put in working shape. The first claims were granted in 1529. In 1865 the French geologists Dollfus and Monserrat visited the country and found that the furnaces employed for smelting the ores were very similar to those of Wales. This demonstrated to them the advancement in which metallurgy then stood in Central America. Since 1847 an Anglo-Franco concern has worked the silver mines of Alotepeque, located in the southern part of the country near the borders of the Republic of Salvador. These mines sent to the mint 150,000 dollars per annum, and, besides, exported to England

the richer ores. This mine was abandoned on account of the depreciation of silver, and also because the machinery then existing did not allow its further economical exploitation. The silver ores were not exhausted, and on the dumps could be found all the zinc and lead ores extracted at the same time, as they were useless and even prejudicial for the purpose pursued. In 1899 this mine was patented anew, by Horta & Co., as zinc and lead layers, but it was only in 1912 that the thorough development began; it is from this region that ores are actually exported.

In the northeastern part, the sands carried by the rivers that flow from the mountain range that divides Guatemala and Honduras contain gold; many claims have been granted and some already have permanent machinery established.

During these last two years, the mining and geological service of the Republic, as well as private enterprises, has investigated in regard to the possible existence of oils and bituminous matters in the subsoil; and we cherish the hope, based on the data collected, that they really are to be found there.

Many other minerals outcrop and can be easily detected, but the principal factor for such undertaking is lacking—capital. The new mining law provides that during the first fifteen years that follow its promulgation, no duty shall be paid on machinery introduced for such purpose and no tax will be paid on such machinery, showing thus that the Government is desirous of giving its best help to the capital invested in such enterprises.

We need to be better known, better studied, in order to be helped to the development of that natural dormant wealth. We need the cooperation of serious and well intentioned concerns that will help to the development of our national wealth.

It is for me a great pleasure to be present at this meeting, hoping that from its proceedings may spring forth new and stronger ties between all the scientific societies here represented, aiming to gather extensive knowledge of the world's resources and their best employ.

I have the honor, as representative of my Government, to thank you for your attention listening to these few remarks, for which I appeal to your indulgence. I thank you. (Applause.)

President Goethals.—I take pleasure in introducing to you the representative and delegate from Japan,—Admiral M. Kondo. (Applause.)

Admiral Kondo.—Mr. Chairman, ladies and gentlemen: On behalf of the Kingdom of Japan, I wish to tender a few words of her appreciation for the courtesy extended by the President of the International Engineering Congress, inviting delegates from Japan to take part in the meetings.

Personally speaking, meetings of engineers always appeal to me in the way nothing else does.

Not only because I am a humble member of the profession, but because I think that among engineers there is a sort of bond which unites us in a brotherhood which knows neither nationality nor class distinction.

The members all strive for one common cause of advancement of technical science.

Nowadays, engineering is so intricately connected with everyday life that it is well-nigh impossible for us to do anything without the aid of engineering; therefore, it is superfluous for me to say what tremendous influence this engineering congress will have upon our welfare.

In conclusion, I just want to wish this International Engineering Congress every success it desires, and I also have the honor to convey the greetings of the people of Japan to the people of the United States of America. (Applause.)

President Goethals.—Netherlands is represented by its delegate, and I am pleased to introduce to you Mr. H. J. E. Wenckebach. (Applause.)

Mr. Wenckebach.—Mr. Chairman, Honorary President, members of the Congress, ladies and gentlemen: I thank the Committee of Management for the opportunity given to me to speak a few words as a delegate of the Netherlands Government and as a representative of the Netherlands Institute of Engineers. This society not only embraces all branches of engineering, but also a very large majority of all the Dutch engineers, whether living in Holland, its colonies or in foreign countries. I feel, therefore, authorized to present to the Congress the very cordial greetings of practically all the Netherlands engineers and their best wishes for a complete success of this Congress.

The United States of America has always exercised great attraction on our engineers and an international congress in this country can be sure at any time to awaken great interest in Holland. The particular reason for this Congress—the celebration of the completion of the Panama Canal, the greatest achievement of engineering skill ever attained in the world—makes this Congress an event of exceptional importance to the whole technical world. Moreover, additional attraction was offered by the fact that it was to be held in this beautiful city of San Francisco, which now offers its visitors the spectacle of a world's fair, as brilliant as has ever been seen before.

There can be no doubt, therefore, that a great number of my countrymen would have come to the Congress, notwithstanding the enormous distance, if it had not been for the European War, which is still going on quite near to our frontier, making it too risky for most of them to leave their homes for so long a time. So only a few of us have been in a position to attend the Congress personally.

I am glad, however, to say that in another way Holland is more fully represented, viz., by five papers which your Committee has deemed worthy of being inserted in the transactions of the Congress.

This Congress stands—as we would say in our language—under the sign* of the Panama Canal, and that gigantic accomplishment is well apt to cast into the shade almost everything else now going on in the domain of engineering, by the grandeur of the scheme and the wonderful methods by which it has been carried out, as well as by the profound changes it will effect in the world's traffic and the relations of nations.

It therefore takes some courage to ask attention at the same time for problems and achievements of a relatively modest kind and more limited importance. However, the cordial invitation of the Committee of Management of this Congress has caused us to eliminate objections of that nature; the more so because, at least, some of our papers deal with engineering problems of a very special kind, such as present themselves in Holland more than anywhere else in the world, and show how these problems have been solved with satisfactory results.

*Sign of Zodiac, i. e., "under the influence" or "auspices of".

I finish by wishing the Congress to be a complete success, as well for the members as for the Committee of Management and the various executive committees. (Applause.)

President Goethals.—I have the pleasure of introducing Señor Alejandro Cantón as the representative of Nicaragua. (Applause.)

Señor Cantón.—Mr. Chairman, ladies and gentlemen of the International Engineering Congress: It is a high honor for me to present to you on the occasion of this meeting my hearty greetings in behalf of and representing the Government and the people of the Republic of Nicaragua, Central America.

The courteous invitation tendered to my Government by the Government of the United States, to be represented and to take part in the sessions of this Congress of the engineers of the world, must be considered as an effect of the altruistic sentiment that is like the spirit of science, as well as a kind and friendly demonstration from the Great Republic to her sister of the South.

For special reasons, my Government could not send to your Congress one of our engineers, and because I do not belong to your honorable body, the contribution of my country to your elevated deliberations cannot be of serious account. But for this disappointment I find a compensation in the knowledge that my country possesses the most powerful stimulus for engineers—we have the raw material, the unknown, that is, a promise for your future conquests.

We are yet an undeveloped country; we are as a blank book, and on its almost virginal pages only a few lines have been written, mainly by you, engineers: first, in the complete surveys and studies of the canal route, which kept and nourished our dreams of a century, before Panama became our victorious rival; and secondly, in the railroads that climb our mountains, in the bridges that span our rivers, in the tunnels of our mines and in the hydraulic works that bridle some of our running waters to give us light and power.

By means of these practical manifestations of your science, is principally how we have learned at home to regard you, engineers, as the heralds of progress; and it is for me a great pleasure to present to you my best respects in this moment, and to

wish that a glorious success be the achievement of this Congress. (Applause.)

President Goethals.—A Spanish engineer accompanying Balboa on his march across the Isthmus, witnessing the discovery of the great Western Sea, is the originator of the Panama Canal idea, and he made plans to that end. Spain followed the subject of the Canal so long as the Central American colonies belonged to her, and continued her interest during the construction of the Canal. As a delegate from Spain, we have Iltre. Sr. D. José de Lasarte, whom I now take pleasure in introducing to you. (Applause.)

Sr. de Lasarte.—Mr. President, ladies and gentlemen: It is a veritable pleasure and, at the same time, a great honor to address you upon so solemn an occasion as this and to transmit to you the most enthusiastic greetings which the Spanish engineers extend to the International Congress of Engineers here assembled, and especially to the American engineers who have given to the world such marvelous proofs of their knowledge and skill.

Barcelona, which city I have the honor of representing, also extends its most hearty and effusive salutations to San Francisco, this most beautiful city that so hospitably gathers unto its bosom all those who, attracted by its fame, arrive from far and wide and to whom it throws open its portals and its heart.

Spain, wherein everything seems to announce a spiritual regeneration and wherein one would say that all is palpitating with a fervent desire of continuing in that glorious legacy of the past, looks with kindly interest upon the wonderful advancement of this American people, who are the school of civilization and of democracy; and Spanish engineering, though very modestly represented in this assembly, on account of the tragic circumstances of the European conflict, awaits with interest the decisions of this Congress, whose labors will undoubtedly be of multiple and prolific transcendency.

My sincerest and best wishes for the success of this Congress. (Applause.)

President Goethals.—I take pleasure in introducing to you Mr. Richard Bernstrom, the delegate from Sweden. (Applause.)

Mr. Bernstrom.—Mr. Chairman, ladies and gentlemen: Of the many congresses, conventions and meetings which assemble in San Francisco during the exposition year, the International Engineering Congress is of paramount interest to my country and to its government.

The development of the natural resources of Sweden, the prosperity of the Swedish people and the economical independence of the country are, on account of geographic and climatic conditions, very largely dependent upon the scientific and persistent skill of men, and especially of the engineering profession. Not being an engineer myself, I can say that the Swedish engineers have been equal to their task. Almost every Swedish student of your profession feels, however, that his education is not complete without a visit to the United States, and every year hundreds of Swedish engineers land in America with a craving to learn from you and from your magnificent and wonderful engineering achievements. The greater possibilities of this country retain many of these men here for long years and sometimes for life. Others return and give us the benefit of what they have learned with you.

This very condition creates a strong relationship between the members of the engineering profession of this country and of ours, and we hail with satisfaction everything that tends to strengthen the ties between your country and our country in this respect. We, consequently, bring you, today, our best wishes and express the hope that this Congress, in the results it brings, will be worthy of the wonderful engineering achievement which is commemorated by the Panama-Pacific International Exposition. (Applause.)

President Goethals.—I introduce to you Prof. Arthur Rohn, the delegate from Switzerland. (Applause.)

Prof. Rohn.—Mr. Honorary President, Chairman, ladies and gentlemen: In response to the invitation transmitted through the Legation of the United States at Berne, the Federal Council of the Swiss Confederation appointed me as representative of my country at the sessions of the International Engineering Congress, which is just opening.

Gentlemen, it is with a deep sense of gratification that I have accepted this mission to come to the great American Republic on behalf of our little Republic; the more so, since,

crossing the ocean for the first time, I knew that I should certainly see in the United States gigantic undertakings which only a country as powerful as this one, and of so tremendous an area, can undertake. I had also the deep-set conviction that I should bring back from this trip a large number of new impressions, as well as valuable information.

Gentlemen, Switzerland would have willingly sent more than one delegate, but times with us just now are not very easy, surrounded as we are on all sides with belligerents. We must devote all our efforts to maintain our neutrality as strictly as possible.

The Swiss Federal Council, however, considered that in spite of and because of the war, it was quite opportune to maintain the ties of friendship between countries that the war has spared—between countries which later on will have the mission of restoring relations between the enemies of today.

Gentlemen, among the men to whom this mission will be entrusted, the engineers will take the most important part.

Gentlemen, your splendid Exposition in San Francisco celebrates the conclusion of a great undertaking of which Europe is as proud as America, and I present my congratulations to its creator.

I also express the wish, gentlemen, that after the war, as in the past, the United States may be permitted to devote all her resources to works of progress and of peace.

In the name of the Confederation of Switzerland and of her engineers, I express the best wishes for the success of the Exposition, for a great future for San Francisco and for the prosperity of the great societies of engineers of America and the achievements of their members. (Applause.)

Dr. William F. Durand.—We had hoped to have had as a pleasant feature of the session this morning, the presentation of the John Fritz Medal to Dr. James Douglas, but we are informed that Dr. Douglas is detained in the East on account of ill health and we are therefore compelled to omit this feature of the program. I feel that you will all concur with me in the hope that Dr. Douglas may soon be restored to health and to activity in the profession which he has so eminently graced.

I now wish to call your attention to a few brief announcements, which I will ask the Executive Secretary to read, after which the morning session will adjourn.

Meeting adjourned at 12:30.

Report of the Closing Session.—Saturday, Sept. 25, 11:30 a. m.

The meeting was called to order by Dr. W. F. Durand, as Chairman.

The Chairman.—Delegates and members of the Congress: The hour approaches when this Congress, like its predecessors, must pass into history. As to the purposes and ideals of such a congress, I quote from the first circular of information issued by the Committee of Management:

"First: The gathering together of a large and representative body of engineers from all civilized countries, with the opportunities which this will present of forming or renewing personal acquaintances, and of interchanging views on the various phases of professional work.

"Second: The reading and discussion of papers before the various sections, and their later publication in such form as to constitute a valuable addition to any engineering library".

Regarding the first of these purposes, circumstances beyond our control have militated seriously against the large representation from across the seas for which we had hoped; nevertheless, I feel that we are to be highly congratulated on the really large number who have come from abroad, and have joined with us in the deliberations of our various sessions; and I feel that we have occasion to entertain a well-grounded hope that this Congress has indeed been the occasion of renewing old friendships and of forming new ones which shall endure through the remaining years of our allotted span of life.

Regarding the papers and the subject matter of our deliberations, it is unnecessary to speak here. They have been before you during the week, and the large numbers in attendance in the various sessions and the interest shown throughout, give good reason for believing that the engineers of the world have indeed nobly responded to our call, and that they have contributed here a series of papers which, with their discussions,

will serve to furnish a well marked milestone of progress in the advance of the engineering art.

The engineer is a great public servant. He stands between the material content of our civilization on the one hand and the materials, forces and energies of nature on the other. On him rests the responsibility for maintaining and carrying forward all of those features which characterize, in a material sense, the civilization of the present day. Let us hope that those who have been in attendance on this Congress may have drawn therefrom some new enthusiasm, some new sense of vocation, some new realization of duty as a public servant, and that we may all go forward with renewed allegiance to the highest ideals of our profession.

There is always a feeling of sadness attaching to the word "good-bye". I like better the central thought contained in the salutations employed by our European brethren, and which we can best render in English by the phrase, "until the next time". And so, as we approach the moment when we must separate, and return, each to his own land and individual sphere of activity, I feel that we should not approach this moment in the sense of "good-bye", but rather in the sense of "until the next time"'.

With this thought in mind, I shall now have the pleasure of calling on the presidents of some of our national engineering societies and on the distinguished foreign delegates who are with us on this occasion. (Great applause.)

Before proceeding with this part of the program, however, I wish to read a cablegram which it has been proposed this Congress might well send as a graceful tribute to the pioneer in the work of constructing great interoceanic canals.

San Francisco, September 25, 1915.

Compagnie Canal Suez,
9 Rue Charras, Paris.

International Engineering Congress held in San Francisco on occasion of Panama-Pacific International Exposition sends cordial greetings to the family of F. de Lesseps, the builder of the first great interoceanic canal and pioneer in the Panama Canal project, the completion of which this Congress now celebrates.

(Applause.)

I shall take this expression of your approval as abundant warrant for forwarding this cablegram.*

I shall now call on Prof. C. D. Marx, the President of the American Society of Civil Engineers, for a few words on this occasion.

Professor Marx.—Delegates, ladies and gentlemen: Like Doctor Durand, who has just spoken, I, too, am moved by a feeling of regret that these pleasant days are about over. Until a few minutes ago we sat in one of the rooms above, still listening to some of the most interesting papers presented before us. It was necessary for the Chairman to bring out his gavel and call the meeting to adjourn before I could get the members to arise. I said to them that according to the words of our illustrious Chairman we should have to adjourn for a period of eleven years. I trust that this comet he spoke of last night, and which he said had been so regular in its career in the past, will deviate and be less regular, and that we may have the opportunity in a far shorter space of time of again meeting our friends from abroad, and all of you whose faces I see before me.

* The following cablegram was received from Charles de Lesseps in reply to the message of September 25, 1915, sent to the Compagnie Canal, Suez:

Sept. 29, 1915.

Chairman, International Engineering Congress,
San Francisco, U. S. A.

Saluant le glorieux achèvement par l'Amérique de la grande voie inter-océanique ouverte au commerce mondial pour le bien des peuples j'exprime au Congrès la profonde gratitude de la famille pour l'émouvant hommage rendu à mon père qui a consacré sa vie au rapprochement pacifique des hommes.

CHARLES DE LESSEPS.

TRANSLATION.

September 29, 1915.

Chairman, International Engineering Congress,
San Francisco, U. S. A.

Saluting the glorious completion by America of the great inter-oceanic thoroughfare open to world's commerce for the good of nations, I forward to the Congress the profound gratitude of the family for the touching homage rendered my father, who consecrated his life to the peaceful bringing together of man.

CHARLES DE LESSEPS.

In behalf of the engineers I desire to thank you, one and all, for coming here and aiding us as you have in making this an event, the memory of which will certainly remain with us for all the years to come.

I thank you. (Applause.)

The Chairman.—We shall now have a word from Doctor J. A. Brashear, President of the American Society of Mechanical Engineers.

Doctor Brashear.—I am not going to say, "Mr. President", because I can say and will say, ladies and gentlemen, delegates and friends: I think one of the great elements of success in this wonderful conference is the wonderfully good fellow we have had at the head of it to take care of us, and I am sure that I voice the sentiment of every man, and woman, too, for the splendid care he has had over us.

It is delightful to meet each and all here. The only sad part is that others of our particular friends are not here. I had a letter from Germany from one of my dearest friends. I had sent him a little photograph, and he wrote back and said, "Ah, how sad I feel that I cannot be over there among my American friends", but he said, "It does my heart good to know that we Tartars and barbarians are not forgotten by our American friends".

I am glad to say I have been associated with some of the most eminent engineers and scientific men for nearly half a century. All those dear people—I cannot help loving them. Do you mind the speech that good fellow gave us at the opening? He just touched the chords of all our hearts, and he was suffering from the rheumatism at the same time. Then we have these good brothers from the Netherlands and from China and Japan. Some of these days this man, Carty, if he lives long enough, will be sending a telephone message over to your Congress when it is held in Tokio. Also he says that some day he is going to send it around the world.

I am going to tell you this; there was a great friend of mine, a wonderful electrician, who told me that he believed that if we go out and talk in the sunlight, the sound waves are ionized and go through the ether, and we may be able to send a message in this way, not only around the world, but

over to Mars. What engineers they must have in Mars, with 270 different lines of canals! They must have a very big bank account there, too, if the canals there cost like the Panama Canal.

We owe a debt of gratitude to the men who built those beautiful palaces at the Exposition. When I looked at the magnificent sight, with all those lights in it and around it, I said, "If Heaven is half as pretty, I want to get there".

I thank you for all your kindnesses to us. I thank Chairman Durand and all of these good friends in California. May you all get to Heaven, and I will see that Saint Peter lets you in. (Great applause.)

The Chairman.—We will next have a word from Mr. J. J. Carty, President of the American Institute of Electrical Engineers.

Mr. Carty.—Mr. Chairman, honored delegates, members of the Congress, ladies and gentlemen: I have the great honor to represent the youngest of the four great engineering societies, the American Institute of Electrical Engineers. Unlike our older brethren in the engineering profession, our whole art had to be founded. It is our proud boast that the members of the American Institute of Electrical Engineers are the men who founded the art of electrical engineering. It is our proud boast that it was members of the American Institute of Electrical Engineers who founded what might be called the first American art, the art of telephony. That was not something which had its roots in the dim past, traced out in the progress of evolution, but sprang up here in America. Practically all of the substantial advances have been American.

I am impressed with the fact of the many different branches of engineering here. That is an evidence of progress and law, immutable as the law of gravity. Where progress results, there must be differentiation and specialization. In fact, the degree in the scale that an organization is entitled to is determined by the extent to which differentiation has taken place. Judged by that standard, engineering has made most rapid advances. With those specializations and the inspiration that goes with them, there is a danger we might work too much alone. This Congress has shown how to overcome that. There

are times when engineers must act as a mass, as specialists come together for a common purpose and acting as a whole. This Congress has shown how that can be done internationally, and we, here in America, must learn the lesson and act nationally and internationally as well. It is in the air. There must be some way provided so that when all the interests are involved we can act as a unit. One of my proudest moments here was when I could join with all the other societies in giving honor to the Exposition engineers yesterday.* We were there to show that the time has come for the advancement of engineers and of engineering. All of the great American engineering societies were represented there by their officers, and the officers of the Exposition let them know that engineering has now reached a point where it is conscious of its great power, conscious of the fact that it is re-building the entire world. That is one of the great lessons we shall all carry away, and I hope before long some practical results will flow from it. My good friend, Doctor Brashear, has never been known to tell a lie. What he had to say about our talking to Tokio therefore must come true. Mr. Henry Scott of the Exposition asked me the other day whether we could arrange it to talk to Mars. I said, "Certainly we could if there were anybody there, and if he would furnish the money".

Now, I wish to say in parting that I hope to live to see the day when we will have a great International Engineering Congress in Tokio, and I think that even if these astronomical bodies should exhibit some aberration, shortening up the period somewhat, that at the time that congress is held, it may be true that whoever is there will be able to speak from Tokio to San Francisco. (Applause.)

The Chairman.—I shall next call on the representative of France, Major Jean L. de Pulligny.

Major de Pulligny.—Ladies and gentlemen: As the Irishman remarked whilst he was marching to be hanged: "When there is but little time left for spending with friends, none ought to be wasted". Well, I hope I am not wasting your time if I ask your leave to convey our thanks, my thanks and

*On the occasion of special exercises at the Panama-Pacific International Exposition in honor of its engineering staff.

congratulations to the President and officers of this Congress, on my own behalf, on behalf of my countrymen and also on behalf of the foreigners who are not represented here. None of those who attended this meeting will ever forget the excellent organization, the good work done in the sections, and the kind reception tendered to all.

As a conclusion to these remarks, allow me to express the wish that after the astronomic period of eleven years which was discovered yesterday, we may all meet again at the next engineering congress of America. Good-bye, gentlemen—farewell. (Applause.)

The Chairman.—I will next call on the representative from Canada, Mr. J. G. Sullivan.

Mr. Sullivan.—Mr. Chairman, delegates, ladies and gentlemen: This is a great honor, which I thoroughly appreciate, and I am very sorry at this time that I am an engineer, for the reason that engineers are made. They will pick up a green, country boy, put him through the mill, and he comes out an engineer. But orators are born; they do not make engineers of them, but they make passenger agents, freight agents and such like. (Laughter.)

I am afraid that possibly we have been a little negligent in not more of us attending the meetings here, not sending representatives enough to properly tell what we are doing in Canada; therefore, with the gracious consent of the President and the other engineers, I wish to say a few words about Canada.

I did not have time to prepare a paper on this subject, nor did I have the information from which to prepare a lot of statistics, for which I know you are thankful. Therefore I am simply giving you some general impressions that I have formed after twenty-two years of nearly continuous residence in Canada, for the greater part in Western Canada.

Not depreciating the great mineral wealth, lumber industry, fisheries and other natural resources, you will understand that when you have a wheat field 800 miles long and 400 to 600 miles wide that the great natural resource is agricultural. We will ship out, this year, some five hundred million bushels of grain; half of this will be wheat. This land

was held at from $1.00 to $2.50 per acre for a number of years, and when the awakening took place about 1902, land values doubled every two to three years, until the price of land now is from $10.00 to $40.00 per acre. As a further example, in 1903 Saskatoon consisted of a couple of saloons, two livery stables and a few shacks. In 1913 Saskatoon had over 50,000 people, municipally owned street railways, city water works, city sewers and miles of paved streets. And this is only an example of from fifteen to twenty such towns, to say nothing of the hundreds of smaller places. Is it any wonder that railway earnings went up by bounds of 25 to 30 percent per annum? Is it any wonder that we got to gambling in city real estate and possibly went a little too far and built some railways that the development would not warrant? However, in the past two years, certain events have taken place that gave us an excuse for putting on the brakes. Our surplus workmen have been taken care of; the price of our farm produce has been greatly increased; and best of all, the minds of our people have been diverted from real estate gambling to the great natural resource, namely, the land; and I look for a natural healthy development as the result. With less than one-tenth the population of the United States, we have three trans-continental railway systems—two of them crossing the country without reaching an altitude of very much more than three thousand feet. When you stop to think that the work done, and consequently the fuel consumed in raising a loaded freight train one thousand feet is equivalent to hauling that same train a distance of 100 miles on a level, and if you realize that fuel is the largest factor in the cost of transportation, you will understand why our Canadian roads can successfully compete with the United States routes, some of which would require tunnels over one thousand miles long to keep their summits on the same elevation as the above mentioned Canadian routes.

In conclusion, I wish to say that with plenty of facilities, and with the minds of the people trained in the direction of "back to the farm", I can only see a bright and prosperous future for Canada—one of the greatest agricultural countries of the world.

I must thank the Congress and the people of California and the President and officers for the kind reception we have received, and we hope that we have kept up our own reputation and the reputation of the Fair. (Applause.)

The Chairman.—I will now call on the delegate from China, Admiral Wei Han.

Admiral Wei.—Mr. Chairman, delegates, and fellow-members of the Congress: Today we meet again, for a closing session of the International Engineering Congress. We, as delegates from the Government of China, wish to convey to you the sincere congratulations upon the success of this Congress. It is a great privilege that we have attended many of the sessions. We have shared with you all the interesting dissertations and discussions rendered by distinguished and reputable engineers from all parts of the world during the regular sessions. China possesses an area of over four million square miles. Inasmuch as we have such an immense territory, it is needless for us to assert here that she has to urge engineering work of various phases, although she has been making considerable progress, as you all notice, during this present decade.

We shall report to our Government much valuable information obtained from you. When we return we shall take with us new ideas and ideals. With these strong forces, China will co-operate with the world in making progress. I thank you all. (Applause.)

The Chairman.—I shall now call on the representative from Guatemala, Mr. F. Cruz.

Mr. Cruz.—Your work is done. You have fulfilled the program proposed, showing to the world what has been accomplished by those true pioneers and scouts of civilization—the engineers.

The marvelous work of the Panama Canal had, as it deserved, the prominent place in your considerations, as it has changed, by its opening, the world's trade, and solved many difficult engineering problems.

Speaking on my account, I must acknowledge that this International Congress, whose principal reason of being is the interchange of ideas and appreciations of each other's capaci-

ties and resources, has completely achieved the end pursued. Many of us have come as scholars to learn from those that knew better and more, and could dispel our doubts or errors. Others more fortunate were able to teach and learn, some only to teach; and to them must go our heartiest thanks because they gave us their knowledge without hope of reciprocity. Altruistically, each one that has been able to learn something of the unknown forces of Nature, of the processes employed to subjugate them to man, has come and shown to all what his experience has been, in order to enable his fellow-workers in the struggle to avoid the same hardships through which he had passed.

All that has been conquered by man over Nature is emphasized by the wonderful palaces built in the Exposition grounds, by the beautiful exhibits there gathered, and proudly you may say that they are worthy of the country, the state, the city and the men that erected them.

In the last years there has been a notable change in all the Latin-American countries, and among them Guatemala. Before, almost all of our boys and students went to seek knowledge and science in European countries; today they come to the great Union of North America to learn what they should do for the advancement, prosperity and better employment of the resources of their own country.

As representative of the Republic of Guatemala to the International Engineering Congress, I feel quite convinced that these reunions will foster the relations between all countries, mostly among the Pan-Americans and bring closer together the ties formed by neighborhood and friendship.

I express my sincere desire for the prosperity of the United States, California and San Francisco, thanking them all for their unbounded hospitality and that they may be able always, as in the past and present, to offer their home to the world for these great tournaments in favor of the progress of human thought. (Applause.)

The Chairman.—I will next call on the representative from Japan, Admiral M. Kondo.

Admiral Kondo.—Mr. Chairman, the distinguished delegates, ladies and gentlemen: The week of unusual interest and

instruction is over, all too soon for us, who had long looked forward to it.

But, during this brief period we had the privilege of listening to papers in various sections, which, alike in quality and quantity, have never before been surpassed. We also met many distinguished members of the profession, not only from different parts of the United States, but also from all quarters of the globe. We have tasted of the true California hospitality, and above all the Committee of Management has shown us how such a congress should be conducted, which we will try to emulate when we have an occasion to have a congress of a similar nature in our country. I hope on such an occasion all the members present here and many more besides will grace us with their presence, when we will try to show them something of the true Japanese hospitality.

I hope Mr. Carty will make it possible to send our greetings by telephone. I say not farewell, but au revoir. (Applause.)

The Chairman.—I will next call on the delegate from The Netherlands, Mr. H. J. E. Wenckebach.

Mr. Wenckebach.—Mr. Chairman, members of the Congress, ladies and gentlemen: I have been asked several times during this week if Mr. Snellen and I had come the whole long way from Holland only to attend the Engineering Congress in San Francisco.

At the opening session of the Congress, I already remarked that European engineers always take great interest in engineering in America and that we considered an international congress in this country, on the occasion of the opening of the Panama Canal, to be an event of exceptional importance to the whole technical world. I should like to explain in a few words to this meeting why this was particularly the case with Holland engineers and that my country, and the Institute I here represent, had indeed special reasons for being represented at a congress in this place and on this occasion.

It will be known to some of you that our Holland-American line has opened a new service of freight steamers from Rotterdam through the Panama Canal to the Pacific Coast of America.

A powerful dredge from Holland with destination for Vladivostock is now lying in San Francisco harbor, on its way to Siberia, having passed through the Panama Canal. Furthermore, if I am well informed, the Chamber of Commerce received this week a wire from our Java-China-Japan line, that this company is prepared to start a monthly service of freight steamers from Java via Manila and Hongkong to San Francisco.

If these plans do not miscarry, a regular connection will be established between your Pacific Coast and our East-India colonies at the opposite side of the Pacific Ocean—a land of marvelous productivity and almost unlimited wants, anxious to enter into friendly and commercial relations with San Francisco, as close as those existing between New York and Holland.

I think this will do—without even mentioning the large Dutch interests in California oil business—to show that indeed my country is very much interested as well in the Panama Canal as in this part of the United States, and that there were good reasons for Holland to be duly represented, both at the Exposition and at the Engineering Congress, held in this city and on this occasion.

I now have to fulfill some very agreeable formalities.

At the opening session, you, Mr. Chairman, told us how, after the outbreak of the European war, the Committee of Management of this Congress, for a moment, considered if, notwithstanding this war, it would be possible to carry out its intentions, and if, under such unfavorable circumstances, any attempt to hold an international congress would not be condemned to be a hopeless failure.

Fortunately you did not allow yourselves to be disheartened and you made it a point of honor to show to the world that even under the present conditions your intentions could be carried out.

This week has shown that you have seen right, and that this Congress was not only possible but that it has been a brilliant success of which you may be proud indeed. In the name of my country and of The Netherland Institute of Engineers, I congratulate you, Mr. Chairman, with this great

success; and personally I may say that I have never attended a congress which has been better prepared and better managed than this one.

My colleagues and I fully realize what ardent labor has been required, how many difficulties had to be overcome in the organizing and managing of this Congress, and I wish to express our cordial thanks to you, Mr. Chairman, to the Committee of Management, and to all those who have participated in the work of the executive committees; thanks for all that you have done not only with regard to the Congress itself, but also to make our long journey hither and our sojourn in this city as pleasant and agreeable for us as they have been, indeed.

We, foreigners, have had a precious opportunity during our journey to San Francisco to meet a great number of your most distinguished engineers on the special train arranged for this occasion, and I wish you to understand how much we appreciate the cordial invitation of the Committee on Transportation for us to join your party on that train, and to thank you for the excellent accommodations during this journey.

I wish to thank especially the chairman and secretaries of your leading engineering societies, whom we have found ready and willing to help us and to give us all information wanted at any time and in every way.

I have also to return thanks for the numerous and highly interesting trips, which have been arranged for the members during the Congress and the preceding days, especially to the gentlemen who have been our kind and competent conductors on these trips.

Ladies and gentlemen, the Chairman, Doctor Durand, has invited me to say a few words of farewell at this closing session of the Congress, but I think I am not going to do this, and, after his own remarks, I am sure that he will forgive me. What I have to say, after the pleasant and interesting days we have had together, is not farewell, but "tot weerziens", which means, "Good-bye, until we meet again". (Applause.)

The Chairman.—I will next call upon the delegate from Nicaragua, Señor A. Cantón.

Mr. Cantón.—Mr. Chairman, Gentlemen of the International Engineering Congress: When, at the opening of this

Congress, I had the honor to greet you on behalf of the Government and the people of Nicaragua that I represent for this occasion, I made a passing reference to the very important engineering work performed 30 years ago in the survey, location and estimate for the Canal by the route of Nicaragua, before Panama became the fortunate rival.

Surely all of you are acquainted with the contention between the two routes and probably some of you agree that the character of that contention was not altogether technical. As it is, the plan adopted lately for the Panama Canal, of building dams and an artifical lake high enough for the operation of the locks, is the same plan that had been adopted in the year of 1888 for the Nicaragua Canal by the engineers of the American company that had the concession from my Government to build it, and that started its construction.

That plan was suggested by Nature itself, that had placed in the center of our isthmus a big body of water, the two lakes of Nicaragua and their navigable outlet to the Atlantic, covering a surface of 10,000 square miles, at 120 feet above the level of the oceans, leaving only about 20 miles to be excavated for the canal, without any bottomless mass of clay to play unaccountable and expensive tricks in the cuts. The Nicaragua route is about 800 miles north of Panama on the Pacific side and about 300 miles by the Atlantic side, making the distance from San Francisco and New York more than two days' sailing shorter than via Panama, even with a longer crossing.

As things stand at present and for the outlook of the development of the commerce of the world, it is sensible to believe that the Nicaragua Canal proposition has yet some future. (Applause.) The Government of the United States has secured from the Government of Nicaragua an option to construct that canal whenever it is deemed convenient.

For this reason, gentlemen, in wishing you God speed, I am glad to do it with the hope that some of you will visit my country when the task comes upon you to augment the number of modern marvels that your skill is realizing all over the world. (Applause.)

The Chairman.—I will next call upon the delegate from Spain, Señor J. M. de Lasarte.

Mr. de Lasarte.—Mr. Chairman, distinguished members of this Congress, ladies and gentlemen: Permit me to express to the organizers of this important world's congress of engineers, my hearty congratulations because of its interesting results, which undoubtedly will produce great improvements in all branches of engineering.

Also permit me to express my gratitude for the kindly feeling which has been shown to the country which my companion, Mr. Campalans, and myself have the honor to represent, at this Congress. We cannot forget that this Congress is held during the world's most wonderful fair, by which the great people of North America celebrate, with the nations of the world, the greatest achievement of modern engineering—the completion of the Panama Canal.

And for this same reason I am glad to remind you that this, the thirteenth work of Hercules, accomplished by the omnipotence of the will and means of the United States, is not only the realization of the dream of Balboa and Cortez, but the accomplishment of the first technical studies of the engineers sent to the Isthmus by King Charles III of Spain about four generations ago.

I take advantage of this occasion to announce to you that Barcelona, our beautiful city of the Mediterranean, is preparing an international exposition of electrical industries and at the same time a general exposition of Spain. The opening date has not been decided upon, on account of the present European conditions, but we trust that it will be announced to the world at an early date. I hope that we shall have the honor of welcoming to our country many of you on this occasion. And now, in expressing to you my farewell, I will not say "good-bye", as I expect to have the pleasure of seeing you again. I thank you. (Applause.)

The Chairman.—We have received a communication from the Australian delegate, Mr. R. M. Wilson; it reads as follows:

> I feel that I would like to present greetings from Australian engineers to those attending this conference, that I can safely say that the work done here will be watched with the greatest interest by all at home, and that it is only the unfortunate conditions at present existing that have prevented Australians from taking a much more active interest.

I will call next on the delegate from Cuba, Mr. José R. Villalon.

Mr. Villalon.—Mr. Chairman, ladies and gentlemen: It is too bad that we should have to part now. It sometimes happens that one meets the person one would like to live a long time with, just on the eve of departure, and that happens now here. We met yesterday and we part today. What yesterday was a great pleasure, today is a great regret. In parting I believe that we carry with us—I think I express the sentiment of everyone of us present here, judging by myself—a deep impression of everything we have seen here that is grand, noble and beautiful.

The success of this Congress has depended principally upon the wisdom and foresight of the directing officers of the same, and I am sure they took into consideration, as part of the program, the celebration of the Panama Canal at this Exposition: that is to say, they have combined what an old Latin poet said is, "The useful with the beautiful". We have had here technical and scientific sessions; they have brought to us a great deal of knowledge; they have brought to us a great deal of data and a great deal of information that we shall seek in future days compiled in the several publications that have been already announced, the usefulness of which will be beyond mere words to express. But that alone would have been a sort of dry matter; they combined, however, these technical matters with the various trips, which at the same time were very useful and socially very agreeable; and, furthermore, they also combined the sessions of this Congress with the Exposition; and I heard said by a very prominent man of the United States a remark, with which I am in accord, that the success of the Exposition was not the machinery—that you see in every part of the United States, even if not assembled in one building, all the things which are exposed in the Exposition—but, the beauty of its architectural feature and of its worked-out details, the harmonious coloring of the ensemble have rather made the great success of the Exposition; and the great success of this Congress is likewise in combining the useful with the beautiful.

I may say, at the same time, that I am going home with

a great deal of regret; for the happy days I have spent here in your company, while enjoying the hospitality of San Francisco, are hard to give up.

Somebody was remarking the other day how far away from home I was, when I told him I was from Cuba. I said, "No, I find myself at home; it is absolutely delightful here", and for me I can say I carry with me to my country a deep sentiment of gratitude and companionship towards you all. There has not been a single thing to mar anything in this Congress. Everything has come out as it was planned, and it shows the wisdom of its organizers. They could not have selected on this occasion a better place than San Francisco. I have heard it said that the climate of San Francisco is disagreeable, foggy and damp; but it dressed in its best colors in receiving us. There was not a single cloud at any time. The ladies who have accompanied us have afforded great pleasure; and as I heard the lady sing yesterday at the banquet to the effect that the ladies had made this life worth living, they brought life to this Congress, and it was necessary that there should be ladies, together with the beauty of the surroundings, to make this perfect.

On behalf of the Government of Cuba and of the Cuban Society of Engineers, I thank you for the hospitality you have shown us at this Congress. (Applause.)

Dr. J. A. Brashear.—Gentlemen, I want to make a motion. I move a vote of thanks, grateful and heartfelt thanks, to Chairman Durand of this Congress, to Secretary Cattell, his splendid associate, and to all those that were associated with them in the organization and development of this Congress; and to the ladies, and to the Californians all, for the splendid time they have given us. Do I hear a second to the motion? I will ask the President of the Civil Engineers to put the motion.

(The motion was made accordingly; there were several seconds to the motion, and the motion was carried unanimously.)

The Chairman.—Are there any other matters that should come before this body? If not, I then declare this Congress adjourned without a day.

Meeting adjourned.

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STATISTICAL

Transactions

The transactions of the Congress are published in eleven volumes, or, as they might more properly be designated, sections, for, owing to the great bulk of the papers and inserts in the section on the Panama Canal, it was found necessary to publish them in two separate volumes so that, including the index volume, there are in all thirteen volumes of publications.

A total of 505 full sets of the transactions was issued, of which 150 were taken by libraries and societies, and 355 by individuals. .

Total Number of Volumes Issued

The Panama Canal—I	1,450
The Panama Canal—II	1,450
Waterways and Irrigation	1,175
Municipal Engineering	1,000
Railway Engineering	1,010
Materials of Engineering Construction	1,110
Mechanical Engineering	1,200
Electrical Engineering and Hydroelectric Power Development	1,325

Mining Engineering	1,000
Metallurgy	935
Naval Architecture and Marine Engineering	800
Miscellany	650
Index Volume	3,725
Total	16,830*

Of the total volumes issued, 11,384 were bound in cloth, 5187 in paper and 259 in special bindings, mostly half morocco, as ordered by subscribers.

In addition to the volumes issued as above, an extra edition of 500 of each of the Panama Canal Volumes was printed and sold, unbound, to the McGraw-Hill Book Co., to be bound and sold by them at their discretion.

Pages of Printed Matter and Square Inches of Cuts, Half-tones and Inserts in the Various Volumes

	Pages	Cuts	Half-tones	Inserts
Panama Canal—I	527	1,135	1,741	5,735
Panama Canal—II	483	948	1,328	9,173
Waterways and Irrigation	753	942	637	1,219
Municipal Engineering	539	121	306	479
Railway Engineering	634	651	960	2,561
Materials of Engineering Construction	656	1,124	454	150
Mechanical Engineering	532	596	1,453	210
Electrical Engineering and Hydroelectric Power Development	559	2,026	1,137	1,926
Mining Engineering	371	195		354
Metallurgy	498	532	628	412
Naval Architecture and Marine Engineering	796	2,471	1,443	3,870
Miscellany	543	974	262	170
Index	273			
Totals	7,164	11,715	10,349	26,259

Total number of papers contributed	240
Written discussions	127
Oral discussions	299
Closures	41

* At the time the Index Volume was sent to press (September 1, 1916) a total of 16,431 of these volumes had been subscribed for. Subscriptions were then still being received and it is believed that a large majority if not all of the volumes remaining in stock will ultimately be sold.

Geographical Distribution of Papers Contributed

Argentine Republic	2	Italy	9
Australia	2	Japan	5
Austria	1	The Netherlands	4
Canada	5	Russia	3
Chile	1	South Africa	1
China	2	Spain	2
France	6	Sweden	3
Great Britain	15	Switzerland	2
India	3	United States	174

Members and Delegates

Members.—There were in all 3670 subscribing members of the Congress, of which approximately 160 were libraries or societies, and 3510 individuals.

Distribution of Membership by Countries

Argentine Republic	56	Jamaica	1
Australia	43	Japan	68
Austria	13	Malay Peninsula	2
Belgium	12	Mexico	14
Bolivia	4	Morocco	1
Brazil	42	The Netherlands	34
British Guiana	2	Netherlands Indies	16
British West Indies	2	New Zealand	12
Bulgaria	1	Nicaragua	1
Canada	129	Norway	8
Chile	19	Peru	13
China	21	Portugal	10
Colombia	4	Portuguese E. Africa	1
Costa Rica	2	Roumania	2
Cuba	22	Russia	29
Ecuador	1	Santo Domingo	1
Egypt	2	Siam	4
France	61	So. Africa	14
Germany	61	Spain	24
Great Britain	104	Sweden	13
Greece	1	Switzerland	10
Hongkong	1	Tunisia	1
Hungary	15	United States	2731
India	25	Uruguay	3
Italy	13	Venezuela	1

Distribution of Membership by States

Alabama	10	New Jersey	70
Arizona	32	New Mexico	7
Arkansas	7	New York	530
California	734	North Carolina	11
Colorado	47	North Dakota	2
Connecticut	31	Ohio	79
Delaware	7	Oklahoma	3
Florida	8	Oregon	48
Georgia	5	Pennsylvania	196
Idaho	21	Rhode Island	13
Illinois	132	South Carolina	1
Indiana	14	South Dakota	5
Iowa	15	Tennessee	10
Kansas	11	Texas	29
Kentucky	11	Utah	32
Louisiana	21	Vermont	5
Maine	5	Virginia	26
Maryland	26	Washington	53
Massachusetts	103	Washington, D. C.	48
Michigan	43	West Virginia	18
Minnesota	23	Wisconsin	27
Mississippi	6	Wyoming	8
Missouri	54	Alaska	7
Montana	33	Canal Zone, Panama	32
Nebraska	12	Guam	1
Nevada	16	Hawaii	17
New Hampshire	4	Philippine Islands	17

Porto Rico 5

Attendance.—The total registration at the Congress headquarters was 815, of which 746 were from the United States and possessions and 69 from foreign countries.

Geographical Distribution of Registering Members

United States and Possessions

Alabama	1	Kansas	1
Arizona	9	Louisiana	2
California	484	Maryland	3
Colorado	9	Massachusetts	8
Connecticut	3	Michigan	4
Florida	2	Minnesota	1
Idaho	2	Missouri	4
Illinois	14	Montana	6

Nevada	7	Utah	11
New Jersey	5	Vermont	1
New Mexico	3	Virginia	2
New York	72	Washington	11
North Carolina	2	Washington, D. C.	9
Ohio	7	West Virginia	1
Oregon	17	Wisconsin	3
Pennsylvania	18	Wyoming	1
Rhode Island	3	Alaska	3
South Dakota	1	Canal Zone, Panama	1
Texas	6	Hawaii	5

Philippine Islands 4

Foreign Countries

Argentina	1	India	1
Australia	2	Japan	8
Austria	1	Mexico	4
Brazil	1	The Netherlands	3
Canada	16	Nicaragua	2
China	5	Scotland	1
Cuba	8	Spain	2
France	1	Sweden	8
Germany	1	Switzerland	2
Guatemala	1	Venezuela	1

Delegates.—United States Government departments, foreign governments and American and foreign engineering societies were represented by official delegates to the Congress, as follows:

	Number Represented	Number of Delegates Appointed	Number of Delegates In Attendance
United States Government Departments	6	13	9
Foreign Governments:			
Barcelona, Spain	1	2	2
Canada	1	3	1
Cuba	1	1	1
China	1	5	3
France	1	1	1
Guatemala	1	1	1
Japan	1	3	3
The Netherlands	1	1	1
Nicaragua	1	1	1
Sweden	1	1	1
Switzerland	1	1	1

	Number Represented	Number of Delegates Appointed	Number of Delegates In Attendance
American Societies	10	27	13
Foreign Societies:			
Argentina	1	1	1
Canada	2	4	2
France	3	4	1
Great Britain	10	15	4
Hungary	1	4	
Italy	2	11	2
Mexico	1	1	1
The Netherlands	1	1	1
South Africa	1	3	3
Spain	1	2	2
Sweden	1	1	1
Switzerland	1	1	1
Totals	52	108	57

Financial

At the time this volume was sent to press (Sept. 1, 1916), the accounts of the Congress had not been finally closed, for the reason that a considerable balance was still due from members for volumes yet to be delivered, while, on the other hand, the exact cost of printing and distributing the Index volume had not been determined. It was possible, however, to make a very close estimate on these future receipts and disbursements. Furthermore, it was not known exactly how many of the volumes of the transactions still remaining in stock would ultimately be sold. Subscriptions for these volumes were still being received, and the total amount stated as receipts from "additional volumes and bindings" (i. e. volumes sold in addition to the volumes which were furnished for the membership fee) is estimated on the basis of enough of the remaining volumes being sold to cover the small deficit in operating expense which would otherwise exist.

It is believed, therefore, that the following figures represent with substantial accuracy the total receipts and disbursements of the Congress as they will appear when the books are closed.

Receipts

Membership fees	$18,350.00
Additional volumes and bindings	23,382.25
Engineers of the Pacific Coast Guarantee Fund	10,000.00
American Society of Civil Engineers	7,740.00
American Institute of Mining Engineers	4,300.00
The American Society of Mechanical Engineers	4,300.00
American Institute of Electrical Engineers	4,300.00
The Society of Naval Architects and Marine Engineers	1,720.00
Interest on bank deposits	340.85
Total	$74,433.10

Disbursements

General Expense.—	
Executive and clerical salaries	$19,721.33
General printing, circulars, letterheads and forms	4,255.25
Stationery and supplies	1,316.56
Postage and expressage	2,394.83
Office rent	2,409.90
Office furniture and fixtures	504.93
Telephone	398.05
Insurance	174.60
Miscellaneous expenses	1,162.84
Total of general expense	$32,338.29
Publication Expense.—	
Printing and binding	$26,469.96
Editorial revision, proof-reading and clerical	3,227.90
Paper	3,433.65
Photo engraving	2,817.10
Reporting discussions	237.55
Miscellaneous	345.91
Total of publication expense	$36,532.07
Delivery of Volumes.—	
Postage and expressage	$ 3,790.39
Covers	236.30
Cartage	157.30
Messengers	51.00
Total for delivery of volumes	$ 4,234.99
Local Affairs.—	
Miscellaneous expenses in connection with headquarters, receptions and excursions	$ 1,327.75
Grand total	$74,433.10

In considering the expenses of the Congress it should be kept in mind that there was in San Francisco no engineering organization with paid officers and office facilities that could absorb any portion of the overhead expense of the Congress. It was therefore necessary to rent offices and maintain a very considerable executive and clerical staff in addition to the services gratuitously rendered by the members of the Committee of Management, for a period of three and one-half years.

SECTION II. ABSTRACTS

PANAMA CANAL.

Paper No. 1. Introduction.

By George W. Goethals.

Subject Matter: Historical; early projects; concession of 1848; commission of 1872 and report of 1876 recommending Nicaragua route. French Co. of 1876; International Congress of 1879; de Lesseps Co. of 1881. Early work. Change from sea-level to lock type. Failure of Co. in 1889. Nicaraguan concessions and plans. Nicaragua Co. of 1889. Early construction on Nicaragua route suspended in 1893. Board of 1895 for further study of Nicaragua plan. Attempts to reorganize Panama Canal Co. Further study and report in 1899 of Board organized under act of 1899 for general study of entire subject. Characteristics of canal as recommended for Panama route. Spooner act of 1902. U. S. treaty with Colombia. Secession of Province of Panama. Board of Engineers of 1904 and report favoring sea-level canal, with minority report favoring lock type. Final adoption of lock type. Characteristics of design as proposed. Size and location of locks, width of canal and methods for control of Chagres River. Estimates of expense.

Statistical tables of canal dimensions and quantities, of canal appropriations and of classified expenditures to June 30, 1914.

Treatment: Historical and statistical. Pages 30; with 1 folding map of Canal Zone.

Paper No. 2. Commercial and Trade Aspects of the Panama Canal.

By Emory R. Johnson.

Subject Matter: Reduction in distances and sailing time affected by the Canal between Atlantic and Pacific ports of the United States, European ports and the West Coast of South America; between Atlantic and Gulf ports of the United States and Australasia, etc. Tonnage, character and sources of canal traffic. In 1899 there were available for Panama traffic, 5,000,000 vessel tons; in 1910 there were available 8,328,000 tons. Monthly records of the use of the Canal by vessels since August 15, 1914; in April, 1915, 38.6 per cent of cargo tonnage passing through the Canal consisted of traffic between the two seaboards of the United States. The effect of the European War on the use of the Canal by the world's commerce. Commerce between the eastern seaboard of the United States and Trans-Pacific countries specially noted. Probable influence of the Canal upon the location and development of American industries. The Canal

and railway rates and traffic. The Canal and American shipping and commerce. Policy to be followed in managing the Canal. Schedule of tolls.

Treatment: Descriptive and statistical. Pages, 35, with six tables.

Paper No. 3. Outline of Canal Zone Geology.

By Donald F. MacDonald.

Subject Matter: Bearing of geology on canal construction; two chief types of topography defined. Description of general geology and its engineering relations; the kinds of rock formations, their location, blasting, dredging and sliding problems; reference to deposits as sources for lime, cement, brick manufacture; deposits suitable for masonry, fills, road metal, sand, concrete aggregate or foundation sites; swamp and river formations which made surveys difficult and added to the cost of building railroad embankments; the use of igneous rocks for building stone, breakwater and sea-wall construction. It is argued that the canal is in no appreciable danger from possible geological instability of the Isthmian land. Structural geology in relation to engineering. The four distinct types of slides in Culebra Cut; causes of slides and their remedies; author concludes that slides requiring considerable dredging are likely to continue for a few years, but without seriously endangering traffic or menacing the general utility of the canal.

Treatment: Descriptive. Pages, 18. Illustrations, 3 line cuts and 1 half-tone.

Paper No. 4. Sanitation in the Panama Canal Zone.

By Chas. F. Mason.

Subject Matter: Sanitary conditions during the French regime; hospitals established, their early defects; high mortality. Organization of a Sanitary Department by Col. Gorgas in 1904; its three divisions. Code of sanitary regulations. Measures taken to control the spread of yellow fever; its control in sixteen months; malaria the most important disease. Six methods used to combat malarial infection; elimination of mosquito breeding places; destruction of larvae; destruction of adult mosquitoes; screening; segregation; quinine prophylaxis; larvacide to disinfect water. Plague. Typhoid fever and dysentery. Pneumonia. Small-pox. Continuation of the Sanitary Department after the completion of the Canal; reorganized as a Health Department with three divisions—Hospitals and Charities, Sanitation, and Quarantine. Cost of sanitation. The results obtained.

Treatment: Descriptive. Pages, 32; bibliography. Illustrations, 10 half-tones.

Paper No. 5. Preliminary Municipal Engineering at Panama.

By Henry Welles Durham.

Subject Matter: Municipal improvements in Colon and Panama a work distinguishable from that of the Department of Health. Investigation for a feasible water supply for the City of Panama the first problem of Chief Engineer Wallace in June, 1904; the general unsatisfactory state of town water supplies; a gravity water supply proposed for Panama, August, 1904, to cost $440,000; also plans for a combined sewerage system for the heart of the city, with a separate plan for outlying districts, estimated cost $257,000. The adopted plans included: Waterworks; Rio Grande Reservoir, maximum storage capacity, 400,000,000 gals.; supply line to Ancon; distributing reservoir at Ancon, 1,000,000 gals.; distributing system; estimated supply 60 gals. per head per day for 30,000 population; Sewers; 65,831 ft. vitrified pipe, 6 to 24 inches; 2096 ft. concrete storm sewers, 24 to 36 inches; 261 manholes; 227 catch basins. Delays in securing material through purchasing department at Washington; use of equipment left by French company; difficulties in procuring and recruiting laborers. Conditions in Panama bad during the first year of work; yellow fever and malaria prevalent; quarters for men unavailable. The beginning of road construction; the paving of city streets with brick or concrete. Cost of the preliminary municipal works; unit prices.

Treatment: Descriptive. Pages, 38. Illustrations, 1 line-cut, 12 halftones, and 2 inserts.

Paper No. 6. Municipal Engineering and Domestic Water Supply in the Canal Zone.

By George M. Wells.

Subject Matter: An introduction describes the various departments under whose direction municipal work was done during the period 1904 to 1915. Street and road work, of six classifications: brick and concrete pavements, largely confined to Colon and Panama; the remaining types found mainly in the other towns of the Canal Zone. Construction, wearing qualities, costs, total mileage built of each class. Sewers: construction simultaneous with that for streets, roads and water supply; with one exception all towns in the Canal Zone dispose of sewage by gravity flow; Colon required pumping stations; both separate and combined sewerage systems have been built, but policy has been to install separate systems where practicable. Domestic water supply: Panama and the southern end of Canal served from Rio Grande and Cocoli Rivers till 1913; character of works, water analyses; early water supply for Colon and the northern end of the Canal. Agua Clara water works and purification plant for the town of Gatun; cost $250,000. New Mount Hope water works and purification plant for Colon and Cristobal; cost $280,000. Permanent water

supply for the southern end of the Panama Canal; estimated cost $1,250,000. Average cost of filtration at New Mount Hope plant is $0.0139 per 1000 gals.; at Agua Clara, $0.0176. It is estimated that the average cost of water delivered to consumers on all parts of the Isthmus will be 10c per 1000 gals. Total expenditures for all municipal works since June, 1904, is $12,652,000.

Treatment: Descriptive. Pages, 32. Illustrations, 1 line-cut, 6 halftones and 3 inserts.

Paper No. 7. The Working Force of the Panama Canal.

By R. E. Wood.

Subject Matter: Labor and material the two fundamental problems. "Gold" and "Silver" labor forces. Maximum force employed each year, 1904 to 1914. Steps taken to recruit the working force; difficulties encountered in 1904-5 to secure first-class men; recruiting offices in the United States abolished in 1911. The three classes of "Gold" employees. Why it was difficult at first to get unskilled labor; objections to recruiting by West Indian governments; laborers recruited under contract. Relative efficiency of West Indian and European labor. Little recruiting necessary after 1909. The evolution of the unskilled laborer. Steps taken to insure an efficient and contented force; by furnishing wholesome quarters, good food, maintaining healthful conditions; by the compensation act; by leave privileges; etc.

Treatment: Descriptive. Pages, 16.

Paper No. 8. Purchase of Supplies for the Panama Canal.

By F. C. Boggs.

Subject Matter: The classes of supplies. Construction supplies only are discussed. Their requisitions. "Open-market" purchases versus purchases by advertising. Awards, methods of making; publicity; the rule preventing changes in bids. Restrictions to purchase of foreign material. Contracts and orders. Inspection, tests and reports before shipments. Follow-up system. Records of orders and system of checks. Forms and their usefulness.

Conclusions: Specifications should define the cheapest material which under the circumstances will meet needs; where practicable, specifications should call for standard commercial products; specifications and contract should protect contractor as well as Government and contain as few uncertainties as possible; certain definite fixed rules should be adopted in making awards; both contractor and the unsuccessful bidders have rights which should be observed by the Government; the final decision in interpreting contract must devolve upon a government official.

Treatment: Descriptive. Pages, 18.

Paper No. 9. The Climatology and Hydrology of the Panama Canal.

By F. D. Willson.

Subject Matter: Data presented in paper compiled in part from records of the Isthmian Canal Commission, the Panama Canal, the Panama Railroad, and the Old and New French Companies, but principally from the records obtained under the direction of the Isthmian Canal Commission since the American occupation of the Canal Zone. The geology of the Isthmus. Topography. Meteorology: Stations and equipment; climate; precipitation, local distribution, monthly distribution; hourly distribution, number of rainy days, excessive precipitation; air temperature, hourly variations; winds, monthly and hourly variations, maximum velocities, Sosa Hill wind records; fogs; cloudiness; relative humidity; atmospheric pressure; northers; records of evaporation; sea temperatures; miscellaneous phenomena—thunderstorms, hail, halos and corona, water spouts. Tidal phenomena. Seismology. Hydrology: the Chagres River; the Trinidad and Gatun rivers; the Cano; the Obispo; the Chilibre; hydrographic stations; floods of 1879, 1885, 1888, 1890, 1893, 1906, 1909, 1910, 1911, 1912; run-off; evaporation; Gatun Lake; Miraflores Lake; prediction of rises; study of relation between rainfall and run-off for Gatun Lake watershed during filling of Gatun Lake, May to December, 1913. Current observations taken below the west lower operating gates; the filling of Culebra Cut.

Treatment: Descriptive and statistical. Pages, 112, with 56 tables, 6 insert diagrams, 5 half-tones and 56 diagrams in text.

Paper No. 10. Dry Excavation of the Panama Canal.

By George W. Goethals.

Subject Matter: Early work by French Co.; total amount excavated when United States began work; equipment used by French. Improved equipment available for U. S. work. General topography and character of formations along line of Canal. Diversion channels; pumping equipment for removing collected water. Program of operations connected with removal of material from Canal prism. Mechanical equipment required; explosives employed; general system followed in drilling, loading and firing the holes. Steam shovel equipment; maximum shovel records; removal of material excavated by shovels. Handling of dump trains. Statistics of locomotive and rolling stock employed. Statistics showing quantity and distribution of spoil. Methods of handling and spreading spoil. Methods of track shifting employed. Special difficulties at particular points. Slides and the difficulties and delays experienced in consequence of slide movements; various types of slides. Dry excavations at various points other than through Culebra Cut. Quantities of excavations along line of Canal distributed according to various sections of work.

Treatment: Descriptive. Pages, 52. Illustrations. 17 half-tones and 2 inserts.

Paper No. 11. Construction of Gatun Locks, Dam and Spillway.

By W. L. Sibert.

Subject Matter: Test pits and test borings. Construction of Gatun locks: lock excavation; concrete forms; placing of concrete; cost of concrete; setting temperatures of concrete in large masses; construction plant, Gatun locks; construction of south guide wall. Construction of Gatun Dam: dam sections; tests of material available for construction; tests of material underlying dam; drain pipes; slides in Gatun Dam. Construction of the spillway and diversion of the Chagres River.

Treatment: Descriptive and statistical. Pages, 38. Illustrations, 1 diagram, 20 half-tones and 16 inserts.

Paper No. 12. Methods of Construction of the Locks, Dams, and Regulating Works of the Pacific Division of the Panama Canal.

By S. B. Williamson.

Subject Matter: Outline of general design of plant for the construction of Pacific locks and dams of the Panama Canal; quarrying and crushing plant; sand production; transportation; cement storage; power house. Handling plant, including description of berm cranes and chamber cranes. Construction methods at Pedro Miguel, including lock excavation, preparation of foundations, concrete construction, arrangement of main construction plant; performance of cranes. Construction methods at Miraflores, including same items as under Pedro Miguel. Dams and regulating works, including west dam at Pedro Miguel, east dam at Pedro Miguel, west dam at Miraflores, and east dam at Miraflores. Special features, including concrete barges, lock guide walls and concrete lamp posts.

Treatment: Descriptive and statistical, including a large number of unit costs for concrete, earth and rock construction. Pages, 33. Illustrations, 10 half-tones and 14 inserts.

Paper No. 13. Dredging in the Panama Canal.

By W. G. Comber.

Subject Matter: Early work done by French Company. Types of dredges used by French Company; ladder dredges; suction dredges. Dredging by U. S. Atlantic Division; equipment employed. Dredging fill in Gatun Dam; dredging inner harbor at Cristobal; dredging for breakwater at Colon; sand dredging at Nombre de Dios. Dredging on Pacific Division; equipment employed; general methods of work; hydraulic excavations, pipe lines and monitors, dredging pumps; dredging harbor at Balboa; dredging sand for building purposes. Dredging in the Central Division; equipment employed; general methods of work; dredging at the

Cucaracha slide; dredging the new Culebra slide; gravel supply. Tabular matter giving performances of various dredges, together with costs of operation.

Treatment: Descriptive and statistical. Pages, 67. Illustrations, 10 diagrams and 17 inserts.

Paper No. 14. General Design of the Locks, Dams and Regulating Works of the Panama Canal.

By H. F. Hodges.

Subject Matter: Preliminary work and organization. Features common to all the locks. Dimensions for twin chambers. Walls; material, freeboard. Gates; material, structural framing, intermediate gates, double gates, cross-filling, prisms of lift. Filling and emptying; assumed time, culverts, valves, intakes, access to interior, course of water. Action of water in locks; actual time of filling and emptying, coefficients of flow, disturbance in chamber, auxiliary culverts, reverse pressure on gates. Precautions against accident; double gates, fender chains, towing system, gate recess covers, snubbing hooks, emergency dams, mooring walls. Operating machinery, tunnels, control house. Leakage through gates and valves. Floating caisson. Setting temperatures of concrete.

Local differences in design of locks at Gatun; areas, lifts, foundation, floors, tell-tales, approach walls, fender cribs, wing walls, culvert intakes, side wall discharges, currents. At Pedro Miguel; area, lift, foundation, core in middle wall, floor, approach walls, fender cribs, culvert intakes, discharges, basin above lock, oscillation of water, wing walls. At Miraflores locks; tidal oscillation, area, lifts, foundations, approach walls, culvert intakes, discharges, fender cribs, core walls, salt water in lake.

Design of dams. Gatun dam; location, plan of 1906, first work. Consulting Board of 1909; section proposed, modifications of same. Plan and sections as constructed. Pedro Miguel dam; plan, material, construction, foundation. Miraflores dam; location, material, foundation. West dam.

Design of spillways. Gatun spillway; considerations governing design, required capacity, use of regulating gates. Adopted design; location, construction. Action of water, measured discharge, measured leakage. Miraflores spillway; considerations governing design, required capacity, adopted design, location, cut-off walls, leakage.

Cost of main items.

Treatment: Descriptive and statistical. Pages, 53. Illustrations, 5 half-tones, 6 diagrams and 6 inserts.

Paper No. 15. The Design of the Spillways of the Panama Canal.

By Edward C. Sherman.

Subject Matter: Spillways of large capacities necessary because the high-level type of canal produced lakes which are essentially enormous

storage reservoirs. Gatun spillway, 140,000 sec. ft. capacity; maximum rates of discharge. Design of spillway; coefficient of discharge, gates, baffle piers, spillway channel, electrically operated crest gates, hand hoists. Miraflores spillway, 92,000 sec. ft. capacity; design of the same general type as that at Gatun.

Treatment: Descriptive. Pages, 9. Illustrations, 6 inserts and 3 half-tones.

Paper No. 16. Design of the Lock Walls and Valves of the Panama Canal.

By L. D. Cornish.

Subject Matter: Specifications for reinforced concrete structures; the design of main lock walls; the size and shape of culverts; lock floors; approach walls. Main valves for controlling the filling and emptying system of locks; rising-stem gate valves; ordinary counterweighted type of gate with flexible connection to operating machinery considered but rejected; design of seal to prevent excessive leakage; guard valves; tests of four different sets of valves gave a mean leakage per gate of 1.23 c. f. s. Cylindrical valves.

Treatment: Descriptive. Pages, 21. Illustrations, 1 insert, 5 line cuts and 1 half-tone.

Paper No. 17. Lock Gates, Chain Fenders and Lock Entrance Caissons.

By Henry Goldmark.

Subject Matter: Large size of gates; number and weight. Choice of type; single-leaf type, weight and cost; double-leaf type, weight and cost; shape of leaf and angle of sill; series of estimates and designs. General description of gates; anchorages and gate supports; quoin and miter-post bearings and sills; foot-walks; material and workmanship; stresses; erection; painting; weights and cost. Chain fenders; general character; method of use and mechanism for control; size and strength. Lock-entrance caisson; character of design; dimensions and weight.

Treatment: Descriptive and statistical. Pages, 43. Illustrations, 15 inserts, 8 half-tones and 5 diagrams.

Paper No. 18. Emergency Dams Above Locks of the Panama Canal.

By T. B. Mönniche.

Subject Matter: Necessity for emergency dams. Structural details of dams: use of swing-bridge trusses, center-pivot type, weight 6,700,000 lbs.; vertical trusses; floor beams; horizontal truss; wicket girders and sills; upstream side of sill provided with large sump to prevent material from lodging against the sill; gates; turning and wedging machinery; method used to balance dam about its center pivot; wicket girder hoist-

ing machine; gate hoisting machines. Stresses and system of framing; calculations provide for four conditions of loading. Materials used: carbon and nickel steel for different truss parts; composition and tests for nickel steel specimens and full-size members; important castings of vanadium steel; upper and lower disks of center pivot of forged chrome vanadium steel; center disk of forged manganese-bronze; lubricating grease for disks; friction tests of the West Emergency Dam at Pedro Miguel; friction coefficient for wedges; gate rollers of chrome steel; gate wheels of case-hardened chrome-vanadium steel; friction tests of gates. Erection of dams; inspection; final acceptance tests for each dam; contracts and cost.

Treatment: Descriptive and analytical. Pages, 33. Illustrations, 10 folding plates, 8 half-tones.

Paper No. 19. Hydraulics of the Locks of the Panama Canal.

By R. H. Whitehead.

Subject Matter: Purpose to give mathematical expression to the hydraulics of the locks of the Panama Canal. Arrangement of valves and culverts and expectations of the design. Observed characteristics of the system. Importance of good distribution of water when filling. Discharge through lateral culvert openings when filling locks, neglecting friction. Recommendations for design of lateral culverts and their openings. Friction losses, tabular. Discharge through openings of lateral culverts corrected for friction losses. Total discharge through lateral culverts while filling locks. Characteristics of operation for various laterals. Recommendation for total lateral culvert distribution. Determination of true equations of flow. General discussion of filling and emptying culverts for Pedro Miguel lock. Calculation of value of dynamic head for complex culvert systems. Rising-stem valves; characteristics of operation, tabular. Operation of miter gates; determination of forces required to operate miter gates. Currents in locks due to differences of salinity; theoretical values of currents due to differences of salinity; comparison of theoretical with actual currents, and effects on vessels.

Treatment: Descriptive and mathematical. Pages, 70. Illustrations, 1 insert, 3 half-tones and 19 diagrams.

Paper No. 20. The Electrical and Mechanical Installations of the Panama Canal.

By Edward Schildhauer.

Subject Matter: Principal hydroelectric power station, brief description; reserve station; transmission system; Gatun substation; Cristobal substation; Miraflores substation; Balboa substation; Gamboa substation; Darien substation; transmission line structure. Distribution of power at Gatun locks; transformer rooms, power feeders, lighting. Distribution of

power at Pedro Miguel locks. Distribution of power at Miraflores locks. Machinery for the operation of locks and spillways: rising-stem valve machines; cylindrical valve machines; miter-gate machines; miter-forcing machines; spillway gate machine; guard valve machines. Towing locomotive systems; track, locomotive. Motors; type and characteristics. Electric cables; control of lock machinery; control house; contactor panels; control boards; interlocking of fender chains and miter gates; interlocking of miter gates and miter-forcing machine; interlocking of rising-stem valves; diagonal interlocking of rising-stem valves; interlocking of rising-stem valves with cylindrical valves; interlocks on cylindrical valves; interlocking of rising-stem valve of side wall and miter-forcing machine; water-level indicator; local control.

Treatment: Descriptive. Pages, 56. Illustrations, 10 inserts, 33 half-tones and 6 diagrams.

Paper No. 21. The Reconstruction of the Panama Railroad.

By Frederick Mears.

Subject Matter: Early history; the mule trail or "Royal Road" of 1533; the first railroad complete in 1855, acquired by the French Canal Company in 1883 and by the United States Government in 1904. Rehabilitation of the old Panama railroad during early days of Canal construction to provide for a greatly increased freight traffic; the necessity for a high-level railroad line caused by the adoption of a lock type of canal. Original location of the new railroad. Preliminary construction confined to those sections which would aid Canal plans. The revised location and reasons therefor; new surveys to seek another crossing of the Gatun Valley. Construction work along the accepted line; high efficiency of steam shovel work on embankments; method of placing material in embankments, difficulties encountered, settlements; completing the line; the Miraflores tunnel; the Gold Hill line, necessitated because of serious slides in Culebra Cut; protection to submerged slopes of embankments; reinforced concrete culverts; Monte Lirio bascule bridge; permanent track. Traffic conditions, interlocking and signals. High-tension power transmission line, permanent duct line. Cost of the new railroad. Terminals. Conclusion; bibliography.

Treatment: Descriptive. Pages, 41. Illustrations, 2 line cuts, 3 folding plates, 18 half-tones.

Paper No. 22. Permanent Shops, Pacific Terminals, Panama Canal.

By A. L. Bell and H. D. Hinman.

Subject Matter: Permanent shops for the Panama Canal built for the purpose of repairing machinery and equipment used on the Canal and the Panama Railroad, for the U. S. Navy and for commercial shipping. Shops constructed by Division of Terminal Construction, and consist of

a group of steel and concrete buildings located at Balboa, in close proximity to the new dry dock and to the repair and commercial piers. Machinery installed comprises machines removed from temporary shops, together with new machines purchased to equip shops for purposes intended. Preparation of site; general arrangement; foundations; general character of construction; power equipment; lighting; sanitary arrangements. Tables showing dimensions and floor area of various shops, cost per square foot of floor area, horsepower of motors and distribution in buildings, and calculated illumination for various buildings.

Treatment: Descriptive and statistical. Pages, 38. Illustrations, 11 inserts, 10 half-tones and 2 diagrams.

Paper No. 23. Terminal Works, Dry Docks and Wharves of the Panama Canal.

By H. H. Rousseau.

Subject Matter: Tabular list of terminal works, with total estimated costs. Terminal works at Panama and Colon prior to 1880; terminal projects and works during the period of operation of the French companies—1880 to 1904; terminal work since 1904. Dry dock No. 1 at Balboa: dimensions, foundation; general features; concrete plant; method of placing concrete; forms; mixture; surfacing. Dry Dock No. 2: principal dimensions. Wharves and piers at Cristobal and Balboa: general dimensions; character of ground; type of construction; substructure; superstructure; special types; wearing surface; sheds; cargo-handling appliances; tracks; loads; specifications; assumptions for calculations; concrete materials; sinking of cylinders; excavation; sealing; placing reinforcement and concrete. General comparison of costs of docks and piers, tabular. Naos Island breakwater; Atlantic breakwaters; general dimensions and characteristics of design and construction. Fuel-oil plants.

Treatment: Descriptive and statistical. Pages, 62. Illustrations, 17 inserts, 11 half-tones and 2 diagrams.

Paper No. 24. Coaling Plants and Floating Cranes of the Panama Canal.

By F. H. Cooke.

Subject Matter: General discussion of plant at Cristobal and Balboa. General operation of plant at Cristobal. Method of unloading and stocking coal. Method of reclaiming and reloading. General operation of plant at Balboa. Characteristics of machinery for unloading and for reclaiming and reloading. Delivery chutes and conveyor cars. Track, scales and wharf bunkers. Supply of electric power. Floating cranes; general discussion and characteristics of design and operation.

Treatment: Descriptive. Pages, 29. Illustrations, 12 inserts and 6 half-tones.

Paper No. 25. Aids to Navigation for the Panama Canal.

By Walter F. Beyer.

Subject Matter: The system of aids to navigation in general consists of 16 lighted ranges, 46 lighted beacons, 59 lighted buoys, 7 unlighted target ranges, 81 spar buoys and stakes, 11 reference targets. The paper deals only with such features as are believed to be new. The position of ranges with respect to axes of dredged channels so placed as to insure safe navigation for passing ships; the unreliable nature of the soil and future dredging determine the placement of beacons and buoys. Difficulties encountered in Gatun Lake in transporting materials for the construction of light towers. Two types of tower design required; reinforced concrete designs adopted to prevent deterioration and to withstand earthquakes; tower heights ranged from 24 ft. to 87 ft. 10 ins. Beacons built entirely of reinforced concrete units; foundation, body, roof and lantern pedestal, all save foundations cast at a central plant. The location of gas buoys. Use of incandescent lights and acetylene gas for illumination; the operation of electric and gas lamps; Fresnel lenses, candle power. For economy, flashing and intermittent lights were adopted throughout the entire Canal length; for lighthouse purposes, the Canal is divided into five divisions.

Treatment: Descriptive. Pages, 21. Illustrations, 1 line cut, 2 inserts, 3 half-tones.

WATERWAYS AND IRRIGATION.

Paper No. 26. Artificial Waterways which form Cut-offs on Marine Routes, and Waterways consisting of Natural Channels and Bodies of Water linked by Artificial Channels, constituting Inside Routes.

By C. S. Riché.

Subject Matter: Best-known examples of "cut-off" waterways are Panama, Suez, Corinth, Cape Cod, Kiel and Old Caledonian Canals; and of "inside routes" are the old Erie Canal and its successor, the new Barge Canal, the Illinois and Mississippi Canal, St. Mary's Falls Canal, Welland Canal, etc. The inland waterway along the Atlantic and Gulf of Mexico coasts, known as the "Intracoastal Canal", is of the latter class. General description of its route from Boston to Corpus Christi, Texas (pp. 1-6); commercial advantages of; local zone traffic on; through traffic; engineering questions. Reasons for Intracoastal Canal, paralleling Atlantic and Gulf waterways—lower cost of vessels, lower cost of freightage than by railroads. Short bibliography.

Treatment: Descriptive and analytical. Pages, 12. Illustrations, 1 map in text.

Paper No. 27. The Waterway from the German Rhine through the Netherlands to the North Sea, along the Rivers Rhine, Waal and Nieuwe Maas.

By C. A. Jolles.

Subject Matter: General description of course of Rhine, source to sea. Usually enough water in Rhine to insure regular navigation; flow of Rhine. Rhine used for navigation since Roman times; now navigable up to Strassburg, 735 km. from North Sea. Rhine navigation very important; plans being made to extend it to Bregenz, on Lake of Constance, 1080 km. from North Sea. Rhine navigation regulated by a Central Committee appointed by the Rhine States. Regulation of "normal width" of Rhine through Netherlands—very effective in reducing calamities from floods and ice. History and description of regulation of the Rhine and its various waterways—Upper Rhine, Waal, Boven-Merwede, Nieuwe Maas, etc. Rotterdam waterway, fluctuations, river-profile; minimum depth of 3 meters desired from Cologne to North Sea. New waterway from Rotterdam to Sea through Hoek van Holland—6½ meters minimum depth obtained about 1895, 7½ meters in 1905, 8½ meters in 1912, 10-10½ meters minimum depth desired. Channels very tortuous, marked by buoys and beacons. Rhine traffic increasing very rapidly; ocean traffic through Amsterdam, Rotterdam and Antwerp; goods transshipped at these ports. More than 60 regular steamers from Rhine to Baltic ports.

Tables of tonnage and increase by ten-year periods.

Rotterdam exceeded as sea-port on continent of Europe only by Hamburg (1913).

Treatment: Historical and descriptive. Pages, 18. Illustrations, 2 insert maps.

Paper No. 28. The Natural Waterways of Russia.

By N. P. Pouzirevsky.

Subject Matter: Characteristics of rivers of European Russia as determined by the topography of the watersheds; also of Asiatic Russia. Navigable length of rivers of European Russia and of Asiatic Russia. Characteristics of run-off. Formation of ice on the rivers. Description of important rivers of the Volga basin—the Volga and its principal tributaries, the Oka and the Kama. Connection of the Volga basin with that of the Neva River. Vessels operating on the Volga and tributaries. Traffic on the rivers of the Volga basin and its relation to railway traffic. Improvement works on Russian rivers. Traffic on the rivers of Asiatic Russia. Proposed scheme of waterways from the Volga to the Pacific Ocean. Character and amount of goods transported by river in Russia. Comparison of waterways and railways as a means of transport. Improvement of waterways.

Treatment: Descriptive and statistical. Pages, 22.

Paper No. 29. Natural Waterways in the United States. Review of Recent Progress and Present Tendencies.

By Wm. W. Harts.

Subject Matter: Problems presented. Three stages of inland waterway development. Distribution of waterways. Methods of improvement used. Various systems of interior waterways: Lake system; Mississippi River system (including Missouri, Ohio, etc.); Pacific Coast rivers—Columbia and Willamette, Sacramento and San Joaquin Rivers; Atlantic Coast rivers—Mystic and Providence Rivers, Hudson River, Harlem and other New York Harbor rivers, Delaware River, St. John's River. General observations and conclusions.

Treatment: Descriptive and statistical. Pages, 50. Illustrations, 1 diagram and 17 half-tones.

Paper No. 30. Flood Control. With Particular Reference to Conditions in the United States.

By H. M. Chittenden.

Subject Matter: Preparatory Note. General Principles: Origin of floods; runoff; vegetable cover, forests; stream channels; flood problems; flood forecasts; flood prevention; flood protection; complexity of the problem.

Some notable flood problems in the United States: the Mississippi problem; the Sacramento problem; the Pittsburg problem; the Dayton problem; the Columbus problem; the Kansas City problem; the Los Angeles problem; the Duwamish-Puyallup problem; the Colorado River problem; the Railroad problem.

Treatment: Descriptive and analytical. Pages, 91. Illustrations, 9 maps and 1 diagram.

Paper No. 31. Flood Control in China.

By Charles Davis Jameson.

Subject Matter: History of flood control in China dates from year 2297 B. C.; methods used were confining the rivers by dykes and draining the lands by canals. In the great delta plane of the Yangtze and Yellow rivers there are not less than 60,000 miles of canals, and all its rivers are more or less dyked. There are more than 400 miles of sea wall. Also there are thousands of miles of dykes, canals and sea walls in the Canton delta. Efforts at flood control have been made for 4200 years past. Yellow River the worst of any. General description of rivers; history of attempt at control; methods of building dykes; defense and protection of dykes against washing. Breaks in dykes—description of mending one in 1902. Huai River, conservancy: great Maratime dyke, idols made to control floods. Recent great floods. Report by American Red Cross shows

that practical elimination of floods is possible at a cost justifiable from a business standpoint. Board of three American engineers, with author as general advisor. Conditions at present. Requirements for successful flood control. Estimated cost of control works $30,000,000, plus $15,000,000 bond-interest. Estimated returns from lands, etc., $48,350,000. Estimated annual returns after completion $2,361,000.

Treatment: Historical and descriptive. Pages, 24. Illustrations, 6 insert maps, 13 half-tones and 2 diagrams.

Paper No. 32. Works for the Improvement of Navigable Estuaries.

By Dr. Luigi Luiggi.

Subject Matter: Difficulties in the navigation of estuaries. Dredging versus jetties. Results of jetties and training walls at Venice and at the Delta of the Mississippi. American experience. European experience. Italian experience: port channel of Ravenna; port channel at Venice (with 3 maps); comparative table of port entrances, Ravenna and Venice. Conclusions. Short bibliography.

Treatment: Descriptive and analytical. Pages, 17. Illustrations, 1 insert map and 2 maps in text.

Paper No. 33. On the River Improvement Works in Japan, with Special Reference to the River Yodo.

By Tadao Okino.

Subject Matter: General outline of river improvement works in Japan, with reference to geographical and climatic conditions. Distribution and amount of rainfall. Table giving for principal rivers the drainage area, length of main river and maximum discharge. Table giving for principal rivers the estimated costs of improvement works and the amount completed up to April, 1914. The improvement works on the river Yodo. Drainage area and river course. Flood damages. Design of improvement works with general description of important features. Execution of improvement works, with description of plant employed and method of work. Table showing detailed quantities and costs for the various items of the Yodo improvement works as completed. Bibliography.

Treatment: Descriptive and statistical. Pages, 31. Illustrations, 1 insert map and 1 map in text.

Paper No. 34. Irrigation Enterprises in the United States.

By C. E. Grunsky.

Subject Matter: Introduction: Public or private ownership of land, of water or water-rights, etc.

Irrigation enterprises in the United States carried out: (a) by the land owners; (b) by commercial irrigation companies; (c) under Desert

Land Act; (d) under Carey Act; (e) under U. S. Reclamation Act; (f) under State irrigation district laws.

Government aid to irrigation. General remarks.

Appendix—Irrigation statistics; irrigation statistics in the U. S., from Census Reports. Bibliography.

Treatment: Historical, statistical and analytical. Pages, 29.

Paper No. 35. Economic Advisability of Irrigation.

By F. H. Newell.

Subject Matter: "Does irrigation pay?" Need of irrigation. Capitalizing the sunshine. Various view-points; farmer, land-owner, investor, promoter, State and Nation. Cost of irrigated farms; of the raw land, of levelling and preparing the land, of improvements, etc., for a 40-acre irrigated farm. Farm returns; first a home and a large part of the food of the family, next products which may be sold. Markets for irrigated crops. Profits. Economic farm area. Value of irrigation works. Conclusions.

Treatment: Analytical. Pages, 26.

Paper No. 36. Distribution Systems, Methods and Appliances in Irrigation.

By J. S. Dennis, H. B. Muckleston, and R. S. Stockton.

Subject Matter: Secrets of success; first a sufficient water-supply, second good construction, third a well organized system for delivering water to the irrigator. Good design of various parts of distribution system. Distribution of water to the farmer. Construction. Maintenance. Engineering. Management. Demonstrations. Ownership of project. Water Users' Associations, Districts. Organization of Associations. Conclusion—the human element most important.

Treatment: Analytical. Pages, 12.

Paper No. 37. The Utilization of Groundwaters by Pumping for Irrigation.

By G. E. P. Smith.

Introduction—Purpose of paper to present in brief compass a survey of modern irrigation pumping and a retrospect of the progress during ten years past, etc.

Ground-water supplies—A brief discussion of them throughout California and Arizona.

Well-drilling. Three types of irrigation wells; those dug to full depth, those drilled to full depth, and those dug to water-level and drilled below.

Pumping machinery; plant outfit too often designed by salesmen. Pumps for irrigation, description and types. General description of oil-

engines. Description of electric power and its favorableness to irrigation developments. Economics of pump irrigation, with diagram. Conclusions.

Treatment: Descriptive and expository. Pages, 31. Illustrations, 6 half-tones and 1 diagram.

Paper No. 38. Duty of Water in Irrigation.

By Samuel Fortier.

Subject Matter: "Duty" a very broad subject—deals with legal, administrative, engineering, economic and agricultural phases of irrigation. Paper confined to practice and conditions in the irrigated districts of the United States of America.

Definition and units of measurement; place of measurement; determination of minimum quantity allowed (state laws, state control, court decisions, with tabular information, and water-right contracts). Factors causing variation in "duty"; transmission losses, with tabular information; character of soil and sub-soil; value of water; climate; preparation of land; diversified farming; time and manner of water delivery; kind of crops, with tabular information; the ground-water level; fertility of the soil; methods of applying water; manner of paying for water; the configuration of the surface; deficient or fluctuating supply and statutory and other restrictions. Variations in "duty"; yearly variation, with tabular information; seasonal variation; monthly variation, with 6 tables. Investigating "duty" of water; results of investigation, with much tabular information. Water requirement of crops, with tabular information and diagram. "Duty" of water in relation to future development in irrigation.

Treatment: Descriptive and expository. Pages, 28. Illustrations, 2 half-tones, 1 diagram.

Paper No. 39. Drainage as a Correlative of Irrigation.

By C. G. Elliott.

Subject Matter: Introduction—Over-irrigation leads to swamping. Process by which land is swamped. Effect of surplus water. Alkali resulting from over-saturation; intercepting drains. General investigation of subsoil and groundwater by borings, etc. Drainage by relief wells. Treatment of level lands; water table must be lowered until not less than 4 feet below ground surface. Depth of drains; must be at least 6 to 8 ft. to be effective. Quantity of water to be removed by drains—from one-third to one-half of that applied during the irrigation-season. Interior drains. Kind and grade of drains. Silt-wells or sand-traps. Drainage by pumps. Results of draining. Engineering features of the work.

Treatment: Analytical and descriptive. Pages, 19. Illustrations, 7 diagrams in text.

Paper No. 40. Italian Irrigation.

By Luigi Luiggi.

Subject Matter: General information: Climatic conditions; necessity for irrigation; how Italian irrigation experiences can be useful to Americans; benefits of irrigation; importance of Italian irrigation. How the water for irrigation is provided: underground water—from wells, from infiltration tunnels; storage of rain-water—by reservoirs, small reservoirs and tanks, in large artificial lakes. Lagastrello earth dam, only high earth dam in Italy (69 ft. high). Rock-fill dams coming into favor in Italy; three recent good examples, highest 101 ft. high. Italian masonry dams: Brasimone dam, gravity section, 107 ft. high; Corofino thin-arch dam, 116 ft. high; Badana dam (highest dam in Italy), gravity section, 188 ft. high, with automatic syphon spillway; Tirso dam, now under construction, gravity section, 195 ft. high; two soon to be built 200 and 250 ft. high. Water derived from rivers: Cavour Canal (most important completed canal in Continental Europe)—plans of headworks, weir, etc.; Villo Resi Canal—plans of headworks, weir, etc.; Ombrone Canal (now building)—21,000 second feet, one of the largest irrigation canals in the world—reinforced concrete inverted siphon. Cross-sections of canals. Sales prices of irrigation water. How the water is used and the results obtained: Preparation of the land to be irrigated,—cost per acre, etc.; quantity of water required and economic results obtained—depths, methods, costs of water and value of production, etc.; financial aspect of canal construction—commercial canal companies not successful; necessity for national aid to irrigation canals. Conclusions.

Irrigation most beneficial for the farmer; not a success to canal companies; necessity for state aid to irrigation schemes. Summarized conclusions of paper. Bibliography.

Treatment: Descriptive and statistical. Pages, 47. Illustrations, 9 half-tones, 25 diagrams and 1 map.

Paper No. 41. Irrigation in Lybia (Italian Colony).

By Luigi Luiggi.

Subject Matter: Condition of Lybia three years ago when first occupied by Italy. Public works carried out by Italians. Natural conditions of Lybia. Irrigation water from wells. Irrigation water from reservoirs. Automatic siphon spillways. Future of Lybia depends on irrigation.

Treatment: Descriptive. Pages, 8, with 4 diagrams in text.

Paper No. 42. Recent Developments of Irrigation in India.

By M. Nethersole.

Subject Matter: Introduction: Relation of irrigated area to total cultivated area; recent development of irrigation—irrigated areas by years,

1902-1912; general classification of areas—percentages from Government canals, from private canals, from wells, etc. Progress in government work.

Technical details: Points of technical interest in the Triple Canal—project with map; Merala headworks and under sluices of Upper Chenab Canal, with tables; Upper Swat Canal, tabular information, etc.; hydro-electric installation for continued irrigation and drainage, Bari Doab Canal—with map; 7 large tables of statistics of irrigation works in India.

Treatment: Descriptive and statistical. Pages, 20. Illustrations, 1 map in text and 3 inserts.

Paper No. 43. The Distribution of Water in Irrigation in Australia.

By Elwood Mead.

Subject Matter: Introduction: Methods employed and results obtained; irrigation of almost paramount importance in Australia, essential to stock-raising; importance of irrigation in growing fodder crops, in fruit growing. Irrigation in Australia largely confined to Murray River and its tributaries; present development in Murray Valley. Distribution of water in State of Victoria: Victorian state works for providing rural water supplies; water supplies for household and stock purposes; works for irrigation; the evolution of the present Victoria irrigation system; operation of State irrigation works by the Commission; experiments in water measurement—the Grant-Michell meter, measurement through submerged orifices; Dethridge meter; water-right allotment; the irrigation seasons; tabular and other information as to cost of water to irrigator; rotation schedules; charges for water and costs to the State to supply it; officers in charge of water deliveries; seepage and evaporation. Distribution of water to irrigators in New South Wales, with excerpts from water laws. Interstate agreement for division of water of the Murray River, considering navigation and irrigation. Data of division of water supply, estimated cost of storage reservoirs and of irrigation works.

Treatment: Descriptive. Pages, 32. Illustrations, 1 half-tone, 1 insert and 6 diagrams.

Paper No. 44. Irrigation in Spain.

By J. C. Stevens.

Subject Matter: Distribution systems, methods and appliances: an irrigation system consists of the diversion mains, the main canal and the distribution system. Distribution systems generally are more complicated in Spain than in the United States. All irrigated lands in Spain are levelled by terraces and walls. In general, main canals and laterals are built and operated by a company or the Government, and secondary laterals, etc., by an association of the farmers. Description of the Urgel

Canal; history year 1540 to present time, water-supply, service, methods of operation, etc. Description of Canal de Aragon y Cataluna, built 1796-1909 by Government; description of system, etc. Permanence of construction in Spain; irrigation-structures much more permanent than in America.

Treatment: Descriptive. Pages, 12. Illustrations, 4 half-tones.

Paper No. 45. Irrigation in Spain: Regulations Controlling the use of Water, Metering Water for Irrigation and Methods of Charging.

By J. C. Stevens.

Subject Matter: The Urgel Canal: This canal, representative of older type, completed in 1865 by private company under concession from Spanish Government; now waters imperfectly 62,000 hectares. Main canal and four principal laterals 250 kilometers long, combined; distribution system has nearly 2800 kilometers of ditches. Net income from sale of water power usually less than 2% of cost of project. Payment for irrigation one ninth of all fruit crops, and certain cash payments for truck gardens and alfalfa. Project very unsatisfactory financially; Company now bordering on bankruptcy. No means of metering water under this system. Quantity of water insufficient for good crop production; a portion of the lands receive an undue proportion of water and others suffer from lack of water. Distribution of crops under the system in 1898. (Tabular information.) Very unsatisfactory results from distribution of the water. Urgel Canal lacks all of those elements that go to make irrigation in Northern Italy so successful. Canal de Aragon y Cataluna: This canal system one in which regulation is well-nigh perfect; water completely measured for distribution and water paid for by amount used; Aragon Canal built by Spanish Government and operated by Department of Public Works; begun in 1896 and completed in 1909; 149,000 hectares of land under system. Table giving crop-acreages; 12,000 hectares of land actually watered in 1906 and 30,000 hectares signed up in 1913. Physical features of the Aragon Canal. Organization and regulation. Metering of water, including formulae for flow through gates and coefficients. Charges for the use of water, including table of prices.

Irrigation methods in force on the Aragon Canal a long way in advance of the practice in the United States of America.

Treatment: Descriptive. Pages, 13.

Paper No. 46. Present Condition of Irrigation in Argentina.

By C. Wauters.

Subject Matter: Introduction. Methods of control—by private enterprise, by coöperative action, by partial or complete official control.

Necessary allowances of water for irrigation; official allowances generally too great, and fixed without knowledge. Regulation of water supply. Underground water; not yet used in Argentina for irrigation. Development of public control in Argentina very slow. Payment for irrigation and taxation. Recommendations of International Colonial Congress as to irrigation.

Treatment: Descriptive. Pages, 16.

Paper No. 47. Dams.

By Arthur P. Davis and D. C. Henny.

Subject Matter: Introduction. Masonry dams: Only gravity masonry dams up to 30 years ago; assumptions underlying gravity designs, uplift, etc.; buttress dams and steel dams; arch dams; multiple-arch dams; special features of masonry dams—contraction joints, material (course masonry, rubble masonry, etc.), cement made locally; movable dams; Stoney gates, roller dams, siphon spillways, etc. Earth dams: Oldest form of dams. Not subject to mathematical analysis. Cores of clay puddle or masonry. Failures of earth dams generally have been due to over-topping, piping along foundations or along outlet conduits, or to sloughing. Protective measures—ample spillway capacity and freeboard, flat slopes, cut-off trenches, grouting of foundations, impervious combinations of available materials. Usual slopes of earth dams, layers and rolling. Hydraulic-fill dams; Gatun, Necaxa and Calaveras dams. Miscellaneous—General elements, combination earth and rock-fill dams; rock-fill with timber or concrete facings; protection of water-slope by riprap, concrete, gravel, etc. Failures of dams comparatively rare. Partial bibliography of dams mentioned in paper.

Treatment: Descriptive and historical. Pages, 25. Illustrations, 3 diagrams in text.

Paper No. 48. Earthen Dams.

By William Lumisden Strange.

Subject Matter: Introduction; paper deals first with the general principles governing the construction of earthen dams, then describes how such general principles are applied in the construction of earth dams in India and elsewhere. General principles: theory and practice; friction and adhesion; the historical element. Percolation and drainage. American dams: The "hydraulic-fill dam"; masonry core-walls. Indian dams: Conditions in India; general designs; the section of the dam; settlement; the gorge embankment; inferior foundations; dry-stone toes; berms; the puddle trench; filling of trench; concrete trenches and walls; the puddle wall; foundations; the seating of the dam; material for construction; disposition of material; casing; construction of dam—watering, spreading

and mixing; consolidation; slopes—in pure clayey soils, in gritty soils; pitching. The waste weir; general remarks; forms of weirs, positions of weirs. The outlet: General remarks; the level of the sill; culvert under the dam; head-wall on the center line of the dam. Short bibliography.

Treatment: Descriptive, historical and expository. Pages, 29. Illustrations, 3 diagrams in text.

MUNICIPAL ENGINEERING.

Paper No. 50. City Planning.

By Nelson P. Lewis.

Subject Matter: Definition of City Planning, with illustrative references to such work in various European countries. The elements of a city plan. The transportation system with special reference to means of getting to and from the city as a center of population. The street system, with special reference to the requirements of transportation within the city. Various systems of laying out streets with reference both to a new design and to the readjustment and improvement of existing conditions. Studied irregularity in street arrangement in many cities in Europe. Park and recreation facilities, with table giving, for principal cities of the world, population, area of city, area of parks and density of population with reference to city area and park area. General discussion of features to be realized in parks and recreation spaces, with illustrative examples. The location of public buildings, with discussion of points to be held in mind in determining such location and with many illustrative examples drawn from the principal cities of the world. Adaptation of city design to topography. Details of city design and arrangement. Height of buildings and their limitations, with illustrative examples from the principal cities of the world. Subdivisions of city area into blocks and lots. Financing a city plan. Legislation leading to city planning. The responsibility of the municipal engineer.

Treatment: Descriptive and expository. Pages, 82. Illustrations, 8 half-tones and 12 diagrams in text.

Paper No. 51. London Traffic in 1913.

By Sir Albert Stanley.

Subject Matter: The size of London; the central area, the administrative county; greater London, the outer suburban ring. The traffic facilities of London; railway stations, tramway routes, motor omnibuses. The control and regulation of London traffic; the construction of rail-

ways, the construction of tramways, the licensing of motor omnibuses, inspection and supervision. Some consequences of the un-coordinated character of traffic facilities; in the relations of urban and trunk railway systems, in the conflict of tramways and motor omnibuses, in the exposed position of the motor omnibus industry. The volume of London traffic in 1913; in relation to the traffic facilities, in relation to the population. Fluctuations in the volume of traffic; in the course of the year, in the course of the week, in the course of the day. Diagram showing the hourly variation in the traffic for a normal day on the railways and omnibuses; diagram showing the loading of the trains during the morning rush hours at Whitechapel, District Railway; diagram showing the loadings of the trains during the morning rush hours at Sloane Square, District Railway. Improvements in railway capacity; electric traction and automatic signalling; the elimination of flat junctions; the problem of peak loads. The traffic carried classified and distributed according to rate of charge; on the motor omnibuses, on the tramways, on the railways. The fares charged; factors affecting the amount of the fares, coinage in relation to fares, cost of operating per passenger, the existing scales of fares. The fares problem; the equalization of fares, excessive differentiation of fares, the characteristics of a fares system. The financial results of 1913 and the prospect for the future; the heavy capitalization and the small return, expansion in traffic, advertising for traffic, conclusion.

Treatment: Descriptive and statistical. Pages, 40. Illustrations, 3 diagrams in text.

Paper No. 52. Transit Problem in American Cities.

By W. F. Reeves.

Subject Matter: History and development of transit facilities. New York City with reference to special problems presented by the concentration of the population; brief historical sketch. Rapid transit elevated lines for Manhattan and Bronx. Rapid transit subway lines. Hudson-Manhattan and Brooklyn elevated lines. Omnibus lines in New York City. Surface lines in New York City. General problem of transit in city of Chicago. General discussion of transit systems for cities of Philadelphia, Pa., Boston, Mass., Newark, N. J. Congestion of population and passenger traffic in New York City with special reference to present systems. Proposed improvements. Subways as a factor in taking care of congested condition in New York City. Street surface congestion, with statistical items and a discussion of methods of relief. Regulation of surface traffic at important crossings. The power of suggestion as a factor in city transit.

Treatment: Descriptive and statistical. Pages, 44. Illustrations, 2 inserts.

Paper No. 53. Recent Progress and Tendencies in Municipal Water Supply in the United States.

By J. W. Alvord.

Subject Matter: General problem of water supply, with special mention of two large projects recently carried to completion—the Catskill supply for New York City, and the Owens River supply for Los Angeles—and with further reference to the Hetch Hetchy supply for San Francisco. Brief reference to water supply developments for a number of cities distributed through the United States and Canada. The quality of water for municipal supply. Water filtration, with table giving for successive decades the population supplied with filtered water in the United States and the percentage of urban population so supplied. Comparison of the rapid sand filter with the slow sand filter. Water disinfection by calcium hypochlorite and by liquid chlorine, with brief reference to the ozone process and violet ray process. Table showing decline in typhoid fever death rate in eight large cities following the use of hypochlorite disinfection of the water supply. Water-works pumping engines, with table giving test results in selected cases for large modern installations. Application of centrifugal pumps for municipal water-supply service. The internal-combustion engine as a prime mover for municipal water-supply service. The Humphreys direct-acting explosion pump, with reference to possible use in water-works practice. Accidents to distribution systems. Water consumption per capita in cities of the United States. Fire protection. Equitable rate of charge for water supply.

Treatment: Descriptive and expository. Pages, 29.

Paper No. 54. Municipal Water Supply in France, Belgium, Algeria-Tunisia.

By E. Imbeaux.

Subject Matter: Rules usually applied regarding water supply in France and Belgium. Quantity and quality necessary. Discussion between requirements for potable water and general service water. Single distribution; double distribution. Sources of supply: surface water—rain water, water from brooks, streams and rivers, water from lakes, ponds and artificial reservoirs; underground water—phreatic stratum, wells, drainage, deep strata, borings, artesian wells, infiltration galleries, springs, strata of fluvial valleys, infiltration tunnels and wells, artificial underground water, intermittent filtration. Processes of purification; filtration and sterilization, with emphasis on regular examination and control of the bacteriological conditions. Conduction, elevation, storage and distribution of water. Control of the quality of water. Investigation of water projects. Condition of the cities of France with reference to sources of supply and methods of distribution described under the

following regions: region of the North, region of the East, Paris region, region of the Northwest, Armorican region, region of the West, region of the Central Plateau, region of the South, region of the Southeast, region of the Southwest. Disposable quantities. Price of service. Expenses of installation. Condition of the cities in Algeria. Condition of the cities in Tunisia. Condition of the cities in Belgium.

Treatment: Descriptive and statistical. Pages, 25.

Paper No. 55. Water Supply in Japan.

By S. Inoue.

Subject Matter: Reference to the various recent imperial statistical year books of Japan as sources of information. Outline of history of water-works development, with reference to topography and rainfall. Method of water development and distribution. The ownership of water works, with table giving for the principal cities of Japan the population, the capacity of water works and the date of completion. Sources of water supply. Method of purification, with table showing reduction in number of bacteria in one cubic centimeter of water before and after filtration, as shown by the principal water-works plants in Japan. Consumption of water per capita, with table showing for the principal cities the population and the actual number of people supplied with filtered water. Fire protection. Cost of construction. Basis of charge. Water works of Formosa, Korea and South Manchuria.

Treatment: Descriptive. Pages, 22.

Paper No. 56. The Disposal of Suspended Matter in Sewage.

By Rudolph Hering.

Subject Matter: Brief reference to recent progress in sewage treatment. Only within recent decade has it become possible and economically practicable to collect all city refuse, solid and liquid, at the source, for delivery at suitable points and finally to dispose of its parts so that nowhere along the line either a serious danger to health or a nuisance need exist. Sanitary collection and delivery of sewage with reference to sewerage systems and their proper management and operation. General methods available for removing suspended matter from sewage. The sanitary disposal of sewage. The separation from each other of the floating matter, the settling matter and the liquids. Treatment of floating matter. Treatment of settling matter or sludge. Work of Dr. W. O. Travis of Hampton, England. Work of Dr. Ing. K. Imhoff. The Imhoff tank. Studies by Mr. E. J. Fort regarding use of shallow single-deck tanks. Work of Mr. H. W. Clark on the treatment of sewage sludge. Development by Dr. Gilbert J. Fowler, of Manchester, England, of the Clark process under the name of "activated" sludge. Experiments by Mr. T. Chalkley Hatton, chief engineer of the Sewerage Commission of

Milwaukee, with reference to the use of "activated" sludge. Experiments by the United States Public Health Service of Washington and the Baltimore Sewerage Commission with reference to the use of the "activated" sludge method.

Treatment: Descriptive and expository. Pages, 15.

Paper No. 57. Sewage Treatment by the Activated Sludge Process.

By T. Chalkley Hatton and William R. Copeland.

Subject Matter: Activated sludge process not to be considered as one of sludge digestion only, but as a complete purification process, requiring only the subsequent disposition of the resultant sludge. Brief engineering description of the process. Treatment of sewage by aeration. Studies of Messrs. Black and Phelps; of Messrs. Clark and Adams; of Messrs. Adern and Williams and Prof. Fowler. Experiments at Milwaukee. Cost of operation. Sludge. Costs. Conclusions.

Treatment: Descriptive and expository. Pages, 16. Illustrations, 3 diagrams in text.

Paper No. 58. Sewerage for Low Countries with Special Regard to the Town of Amsterdam.

By A. W. Bos.

Subject Matter: Reference to limitation of paper to the discussion of cases where the level of the land is so low that all superfluous water must be removed mechanically. General statement of problem with reference to design and arrangement of ditches and canals. For towns built under these conditions, statement of proper distribution of area among streets, squares, canals, houses and gardens. Special discussion of sewage problems for the city of Amsterdam. Combined sluicing system adopted as cheapest. General plan of sewerage system with sketch of sections of sewer mains; gradients and velocities employed. The discharge of sewer water a difficult problem for Amsterdam. General results after one year's operation, carrying the discharge from 250 hectares; examination of water in the Zuider-Zee at regular intervals in order to determine degree of pollution from sewage; government may require purification if sea water should become too much polluted. Statement of costs of sewerage systems suitable for such conditions per hectare of area covered, together with working expenses per year, based on the same unit.

Treatment: Descriptive. Pages, 17, with 6 diagrams in text.

Paper No. 59. Streets.

By George W. Tillson.

Subject Matter: General statement of requirements to be met in the design and construction of city streets. Light and air. Traffic with refer-

ence to various widths of streets; character of street; width of roadway; whether occupied by street car tracks, single or double. Grades in connection with design of city streets. Treatment of Broadway, New York City. Foundation of city streets. Stone block pavements. Brick pavements. Wood pavements. Bituminous pavements. Asphalt block pavements. Bitulithic pavements. Repairs on city streets, with systems of repair costs per square yard in several of the large cities of the world. Sidewalks. Street cleaning, with statement of relative cost of cleaning pavements of various kinds.

Treatment: Descriptive and statistical. Pages, 18.

Paper No. 60. Rural Highways.

By L. W. Page.

Subject Matter: General statement of conditions to be met in design and construction of rural highways. Economic considerations in connection with the broad problem of public highways; public convenience as a determining factor; necessity of comprehensive plan. Principal factors in economic efficiency of a road: (1) Cost of construction; (2) cost of maintenance; (3) amount and character of traffic; (4) average unit cost of hauling. General discussion of improved methods of constructing public highways, with illustrative cross-sections representing recent improved practice. Importance of maintenance of improved roads.

Treatment: Descriptive and expository. Pages, 12, with 3 diagrams in text.

Paper No. 61. Rural Highways.

By L. Limasset.

Subject Matter: Limitation of paper to general construction of roads with crushed-rock metalling. Maintenance of crushed-rock roads before the advent of the automobile. Mode of action of vehicles on a road in the case of a perfectly smooth surface; normal action, tangential action. Mode of action of vehicles on roads in the case of a surface not absolutely smooth, with special reference to shocks and percussive action. Actual effects of automobile traffic on pavements; characteristic local breaks and holes due to automobile traffic. Modification of the mode of up-keep of roads resulting from wear due to automobile traffic. Supplementary observations on materials and binders, with statement of essential qualities to be considered in the crushed rock and in a suitable binder. Experiments carried on by Mr. Ramu. Tests applied to determining character of binding material. Probability of development of suitable water binder for crushed rock.

Treatment: Descriptive and expository. Pages, 17.

Paper No. 62. The Construction and Maintenance of Rural Highways.

By Alfred Dryland.

Subject Matter: Statement of general problems arising in connection with rural highways, with special reference to recent increase in automobile traffic. Influence of temperature and weather conditions. Construction of rural highways with reference to recent improved practice; greater depth of foundation; use of Portland cement concrete base; use of tar or bituminous surfacing for macadam roads. Widths of carriageways with reference to amount of traffic per day. Practice regarding cambers. Maintenance of existing highways; general tendency of maintenance of rural highways during the last 10 years; municipal plant for the manufacturing of bituminous macadam and asphaltic carpets; importance of small repairs.

Treatment: Descriptive. Pages, 8.

Paper No. 63. Rural Highways.

By Arthur Gladwell.

Subject Matter: Wide application of term rural highways prior to advent of automobile. Great majority of rural roads were constructed on the water-bound system. Importance of adequate foundations for roads according to the requirements of the traffic; economic difficulties in providing such foundations for all roads. Tar or bituminous compounds incorporated in the structure of the road surfaces advocated with due regard to the high cost of this grade of material. Discussion of general character of road materials, with reference to relative merits of the four principal road-paving materials: asphalt, soft wood, hard wood, stone setts. General problem of foundations, heavy hauling and the use of binding materials. Scarifying old road surfaces. Discussion of patching versus recoating. Economy recommended in the use of the more expensive forms of road surfacing materials. Economic value of tar binding for road surfaces. Discussion of repairs of rural highways, with reference to principal defects to which such repairs are subject.

Treatment: Descriptive. Pages, 13.

Paper No. 64. "Soliditit" Concrete Roads in Italy.

By Luigi Luiggi.

Subject Matter: The ideal paving for roads of heavy traffic; nearest practical approach to such ideal. Pavings with asphalt or bituminous binder. Special characteristics of "soliditit", a special concrete with a high percentage of silica. Compression tests of artificial stone made with crushed granite and "soliditit" cement. Wearing test on sample of same material. The use of "soliditit" for street pavement. The ap-

plication of this material to Italian roads. Extensive experiments on national roads at Alexandria, Torino, Milan, Palermo, Rome and Cascale. A road pavement three inches thick made of "soliditit" after five years showed scarcely any marks of wear, neither ruts, cracks, nor abnormal marks of change under the influence of traffic or variations of temperature from heavy frost in the winter or great heat in the summer. Surface maintenance relatively even and granules of granite wearing away a little more quickly than the surrounding cement. The pavement is not slippery even during frosts. Average dynamometer resistance on such roads equals load/60. Horses' hoofs obtain good grip on "soliditit" concrete surface.

Treatment: Descriptive. Pages 6, with 1 half-tone in text.

Paper No. 65. Thermal and Traffic Effects on Street Pavements.

By James E. Howard.

Subject Matter: Paper based on tests in Cleveland, Ohio, in 1911 and following years and in Kansas City, Mo., in 1913. Cleveland experiments refer to grouted brick; Kansas City experiments refer to cement pavements. Cleveland experiments show that in well laid cement-grouted brick pavement thermal changes are the most destructive influence encountered. Importance of thermal effects in connection with construction of grouted pavements. Phases through which such pavements pass. Formation of cracks due to drop in temperature at night. Strains in tension and compression resulting from change in temperatures. Action of traffic passing over open cracks. Results of temperature stresses on marginal curves and on street car tracks. Unfavorable conditions developed at open ends of streets and at curves, single and reversed. Shearing stresses set up at curves, especially at short reversed curves. The use of unbonded slab joints to relieve shearing stress. The development of longitudinal cracks. The influence of excessive crowning as a source of trouble in the formation of longitudinal cracks. Doubtful utility of expansion joints at curbing. Kansas City presents many streets with concrete slabs, laid full length of roadway and about 30 feet long each. Joints between intended for contraction. Building paper used in contraction joints to separate adjacent slabs. Thermal changes have usually resulted in wide and long cracks traversing the slabs in a generally longitudinal direction. Suggestion of use of tie-rods embedded in concrete and extended from curb to curb. Measured results due to temperature changes. Effect of heavy loads on street pavements. Measured results in the case of wheels of truck carrying load of 5500 lbs. Tabular results showing for varying temperatures the measured depressions and resiliencies on a chord of 12 inches for total direct load of 5500 lbs. Influence of adjacent cracks on depression under wheel loads.

Treatment: Descriptive. Pages, 15.

Paper No. 66. The Struggle Against Dust.

By C. C. Dassen.

Subject Matter: Importance of control of dust in the city of Buenos Aires, especially on macadam roads. The use of a dressing of oil to suppress the formation of dust. Oil employed is the Russian mazout mixed with lighter oils to enable heavy oil to penetrate between the stones; later the light oil evaporates, leaving the heavy oil behind. Proportions of mixture of light and heavy oils. Detailed statistics giving quantities required and costs for the application of this system to five principal avenues in the city of Buenos Aires. Supplementary note on recent progress and improvement in Buenos Aires.

Treatment: Descriptive and statistical. Pages, 9.

Paper No. 67. The Fire Protection of Cities.

By John R. Freeman.

Subject Matter: Comprehensive scope of the general subject of city fire protection; necessary limitations of scope of present paper. Importance of the problems presented; excessive waste involved in destruction by fire; relation between proportion of values burned in the United States and Europe; special studies in certain lines; slow burning and fire-proof factory construction; application of similar methods to the broader problem of city fire prevention; improvements in office building construction during the past 20 years. American building construction a menace in case of a fire hazard resulting from hostile attack by shells and bombs. Fires in general are largely preventable; prevention of fundamental importance. Generally improved conditions regarding construction and prevention. Conditions which have not been improved, with illustrations drawn from conflagration at Salem, Mass., in 1914. Economic considerations involved in fire prevention. The hastening of improvement; importance of educating the public; application of reinforced concrete; utility of automatic sprinklers. Systematic inspection. Inspection under supervision of Insurance or Underwriter Boards. Building codes. Engineering details. Conclusions on best practical means of protecting a city against fire: extension of the public fire department service to the systematic inspection of every room in every individual building; forcing automatic sprinkler protection wherever deemed necessary; the adoption and enforcement of good building laws; an improved supervision by insurance companies; a more systematic, more widespread and more effective education of the public at large; a national or state service of inspection and public information.

Treatment: Descriptive and expository. Pages, 19.

Paper No. 68. Arch Bridges of Hooped Concrete with Cast Iron Reinforcement.

By Fritz von Emperger.

Subject Matter: Early use of steel with concrete. Restricted field of application. Early trials for the construction of arch bridges. Use of steel with special reference to reinforcement for tension. Need of reinforcement under compression; the use of spiral hooping with longitudinal reinforced concrete for compression. General discussion of this combination, with mathematical formulae. The combination of hooped concrete with cast iron for reinforcement under compression and with special reference to application in columns for arch construction. Discussion, with mathematical formulae. Such construction only justifiable for bridges of long span or those intended for heavy loads; architectural considerations as a determining factor; light and graceful appearance of long arches constructed in this manner. Three main items which determine cost of construction: the arch, the abutment and the false-work. Influence of temperature. Use of joints. Various types of false-work, with methods of use. Description of three types of bridges: arches with roadway above, arches with suspended roadway, arches with tie-rods, all with illustrative examples.

Treatment: Descriptive, mathematical and expository. Pages, 29. Illustrations, 6 inserts, 15 half-tones and 5 diagrams in text.

Paper No. 69. Public Utilities.

By Alexander C. Humphreys.

Subject Matter: Limitation of paper to consideration of questions involved in municipal ownership, as compared with private ownership of public utilities. Lack of information on the part of the public on the subject of municipal control of public utilities. Certain aspects of municipal activity relate to inhabitants as a whole, as for example, city plan, streets, fire protection. Others relate more especially to services sold to those who may desire to purchase, as for example, light, transportation and water. These classes of municipal administration involve the waste and lack of efficiency which seem to attach to municipal administration under a republican form of government. The status of water supply intermediate between the two classes. The utilities proper—gas, electricity and transportation systems—involve sale service to those who wish to buy. This presents fair opportunity for private enterprise. Harmful influence due to politics in connection with municipal administration. Investigation by National Civic Federation in 1905. Extended reference to report of same. Certain minority reports with discussion of same. Function of regulating bodies in relation to public utilities. Discussion of detailed problems. Depreciation and reserve for renewals; general discussion of subject of depreciation as a factor in accounting for public

service utilities. Intangible items involved in proper valuation of public utility properties. Illustrations drawn from railway valuations. Suggestions regarding value of engineers as members of public service commissions. General conclusions regarding public ownership as compared with private ownership of public service utilities.

Treatment: Expository and argumentative. Pages, 35.

Paper No. 70. Short Paper on Public Utilities.

By Edward Willis.

Subject Matter: Fire prevention, protection and extinction. Provision of public parks and pleasure grounds. Housing of the working classes. Hospitals, asylums, prisons, etc. Water supply and provision of food. Public lighting by means of gas, electricity, etc. Transportation, including tramways, motor omnibuses and horse vehicles. Bridges and piers for public waterways. Public baths and wash-houses. Educational institutions: public libraries, museums, etc. Public amusements. Markets. Statistical information showing operation and costs involved in various public utilities for the principal cities of England.

Treatment: Descriptive and statistical. Pages, 13.

RAILWAY ENGINEERING.

Paper No. 71. Railways.

By Wm. Barclay Parsons.

Subject Matter: The inception of railways practically one hundred years ago; phenomenal growth in capital invested and number of employees; lack of uniformity in basis on which statistics of different countries are prepared. Statistical tables: Tables I to VI inclusive, miles of line regardless of number of tracks, for Europe, America, Asia, Africa and Australia, by decades from 1830 to 1910 inclusive; Table VII, miles of line per square mile and per 10,000 inhabitants for various countries; Tables VIII to XXX inclusive, length of line, capital invested, equipment, operating revenues and expenses, passengers and freight carried, number and compensation of employees, for 23 of the leading countries of the world, by decades, from 1830 to 1910; Table XXXI, conversion table for units of length, weight and money used in various countries; Table XXXII, comparative statistics, for 1910, of the 23 countries detailed in Tables VIII to XXX inclusive; Table XXXIII, development of locomotives as to size in United States, from 1832 to 1914; Table XXXIV, classification of freight cars by capacity, from 1902 to 1914 inclusive; Table XXXV, mileage of various gauges in use in selected countries; Table XXXVI, mileage of various gauges in use in United States, from 1840 to 1914; Table XXXVII, summary of persons killed and injured in various

groups of countries, in 1880, 1890, 1900 and 1910; Table XXXVIII, summary of persons killed and injured in each of 16 selected countries for 1880, 1890, 1900 and 1910, and in the United States for 1911 to 1914 inclusive; Tables XXXIX to XLVI inclusive, relative standing of various countries in 1910 in respect to passengers, employees and others killed and injured, per passenger carried, per passenger mile, per employee, and per mile of line.

Development of government and private ownership in the United Kingdom and the United States; State Railroad Commissions; the Interstate Commerce Commission; list of the various state railroad and public utility commissions in the United States, with date of establishment and outline of functions and authority of each.

Table XLVII, comparison of taxes and dividends paid by United States railroads from 1898 to 1913 inclusive; development of government ownership in Europe, India and Asia; Table XLVIII, division of ownership between governments and private corporations in 30 countries for 1880, 1890, 1900 and 1910. Appendix—Acknowledgments and bibliography.

Treatment: Historical, statistical and analytical. Pages, 46. Illustrations, 2 diagrams.

Paper No. 72. The Status of the Railways of North and South America.

By F. Lavis.

Subject Matter: General considerations; the relation of North and South America to Europe in respect to finance, commerce and manufacturing; the stimulation of American manufacturing and commerce as the result of the European War. The development, ownership, physical characteristics, equipment, traffic, earnings, regulation and financing of the railways of North America, Central America, the West Indies and South America. North American Countries: Canada, United States, Alaska, Newfoundland, and Mexico. Central American Countries: Guatemala, Salvador, Honduras, Nicaragua, Costa Rica, Hayti, Santo Domingo, Barbados and Trinidad. South American Countries: Dutch Guiana, British Guiana, Venezuela, Colombia, Ecuador, Peru, Bolivia, Chile, Argentine, Uruguay, Paraguay and Brazil. Appendix: Ten statistical tables.

Treatment: Descriptive, analytical and statistical. Pages, 73.

Paper No. 73. Italian Railways.

By Luigi Luiggi.

Subject Matter: Earnings and operating expenses on State lines; traffic conditions; government policy; private and state management. Technical conditions; bridges; viaducts; tunnels; steam locomotives; electric locomotives; the effect of electric traction; conclusions as to the de-

sirability of state management. Appendix giving corrections which should be made to revenues and expenditures to make them comparable with those of French, German and English railways.

Treatment: Historical and descriptive. Pages, 23. Illustrations, 1 map and 10 half-tones.

Paper No. 74. The Status of Indian Railways.

By Victor Bayley.

Subject Matter: Mileage, gauge, and the necessity for the large mileage of narrow gauge lines. Classification of the varying degrees of state control of railways, and mileage in each class. Financial results, capital outlay, revenue and working expense. The State Railway Administration.

Treatment: Descriptive and analytical. Pages, 9.

Paper No. 75. The Status of Chinese Railways.

By Charles Davis Jameson.

Subject Matter: History of early railway projects in China. The Kaiping Railway and inauguration and development of the present system: government ownership; "The Railway Concessions"; present status as to mileage, gauge, cost, traffic, earnings, and operating expenses of the Peking-Mukden, the Peking-Hankow, the Tientsin-Pukow, the Peking-Kalgan, the Canton-Hankow, the Shanghai-Nanking and the Canton-Kawloon railways.

Treatment: Historical, descriptive and statistical. Pages, 8. Illustrations, 1 map.

Paper No. 76. General Presentation of the Present Condition of the Railway System in Russia.

By V. A. Nagrodski.

Subject Matter: Mileage; gauge; grades. Analysis of statistical data; traffic; receipts; tariffs; war tax. State ownership. Bibliography. Statistical tables.

Treatment: Analytical and statistical. Pages, 15.

Paper No. 77. The Status of Railways and Tramways in the Netherland East-Indies.

By E. P. Wellenstein.

Subject Matter: Length of railways and tramways in the Netherland East-Indies; the system developed on the Islands of Java and Madura,

partly by private enterprise and partly by the State. Conditions governing cost of construction, length of lines, frequent harbours and consequent light traffic; gauge, speed, cost, rail sections and weight of locomotives; electrification. Nature and amount of traffic, earnings and interest on investment. Development of railways and tramways on the Island of Sumatra; length, traffic, earnings, state ownership. Railway legislation; concessions, regulation, speed limits, compensation for railways taken over by the State.

Treatment: Descriptive and statistical. Pages, 15.

Paper No. 78. Economic Considerations Controlling and Governing the Building of New Lines.

By John F. Stevens.

Subject Matter: Definition of economic considerations; three axiomatic financial principles; conditions of growth, foreign systems; present United States systems; planning future United States lines; railway laws governing same; creating of large systems in the past; branch, versus independent lines; probable results necessary to attract capital; care with which data should be secured; reasons for many failures in railways; promotion without adequate cause or knowledge; effect of laws and regulating commissions; politic considerations; public support; local financial aid; promotion stock; necessity for utmost conservatism. Railway planning, exact science; qualifications necessary for engineer; careful study of proportion passenger and freight earnings, as governing character of road; proper grades and curves closely allied to economics; no assumption of physical character of line without detailed knowledge of topography; failures in location. Financial status dependent upon balance ton and train miles; economical adjustment of engine runs, and distribution of power; permanent, versus temporary work; true economy of latter in many cases; many important items of cost are fixed, regardless of character of road. Necessity for ample, properly located and well planned terminals; no other one cause contributes so largely to cost of operation, or inefficient service. Railway promotion in the future.

Treatment: Descriptive and analytical. Pages, 14.

Paper No. 79. The Locating of a New Line.

By William Hood.

Subject Matter: Definition of a suitable location; modification in first construction sometimes necessary if new line is not an extension of a prosperous road. Early losses in operation and time necessary to amortize them. The question of whether to build for the traffic of the near or more distant future. Portions of the investment that can be regulated by character of construction and those that are fixed by the location. The

grade system the most important. Reduction in first cost made by use of sharp curvature. The rebuilding of such a road to meet increased traffic necessitates reconstruction of short sections only. The first cost of a valley line cheapened by introduction of velocity grades. The meeting of valley and mountain grades; desirability of using the same class of locomotives on each. Illustration of actual performance of Consolidation and Mallet locomotives on 0.4% and 1.0% grades. Passenger trains need not be considered in fixing grades; illustration. The use of temporary steep grades. The possibility of adjusting operating expense to volume of traffic, whereas interest on investment cannot be so adjusted. The use of curvature to reduce first cost of valley lines. Effect of such curvature on speed overestimated; illustrations. Other effects of curvature not thoroughly established. Justification of sharp curvature on steep mountain sides. Necessity of careful consideration and comparison of alternate lines. Taper curves; their advantages and various forms; illustrations. Necessity for accurate instrumental work on preliminary as well as final location. Scale of working plats to be used in precipitous or heavily overgrown regions. Rectangular coordinates. Reduction of grade rates on curves. Practice of the author. Final comparison of alternative lines. Necessity for extreme conservatism in predicting traffic. Rate of interest to be used in capitalizing operating expenses. The author's method of comparing operating costs on a proposed line with the known operating costs on an existing line. Elements to be considered. Locomotive and car expense, train crews, maintenance of road, cost of fuel and fuel transportation. Train resistance; relative expenditure and cost of power for grade and curvature. Cost of road maintenance for passenger and freight trains; illustration. Tables A and B, giving respectively the cost of one train mile with two Consolidation locomotives and one Mallet locomotive. Analysis of comparison.

Treatment: Analytical. Pages, 16.

Paper No. 80. The Locating of a New Line.

By David Wilson.

Subject Matter: The topography and physical characteristics of South Africa. Economic conditions under which lines were built and the types adopted for the pioneer lines; gauge, grades and curvature; methods used to surmount heights—steep grades, zigzags, development and heavy work; gives examples particularly of the development work. General principles followed in locating railways those laid down by Wellington in "The Economic Theory of Railway Location". Exceptionally heavy locomotives used; values assigned to units of curvature, grade and length. Field methods in general use. Note as to line of 23.6" gauge in German Southwest Africa.

Treatment: Descriptive and analytical. Pages, 8.

Paper No. 81. Construction Methods and Equipment of Railways.

By William Griffith Sloan.

Subject Matter: Increase in labor-saving devices due to decrease in supply and efficiency of unskilled labor. Railroad construction divided into seven principal classes of work: (1) Clearing and grubbing, (2) excavation and transportation of roadbed material, (3) tunnels, (4) bridges, (5) track laying, (6) ballasting, (7) miscellaneous structures. The methods and appliances now used for each class of work described.

Treatment: Descriptive. Pages, 12.

Paper No. 82. Railway Construction Methods and Equipment in Australia.

By Maurice E. Kernot.

Subject Matter: Percentage of railroads in Australia owned and operated by the Commonwealth and state governments; mileage open for traffic and under construction. Advantages and disadvantages of the two methods followed on construction work under the Commonwealth and state governments—large contracts and direct labor most common types of construction equipment and tools. Organization diagram of the construction staff of Victorian Railway Department.

Treatment: Descriptive and analytical. Pages, 16.

Paper No. 83. Tunnels.

By Charles S. Churchill.

Subject Matter: Recent increase in the rate of tunnel construction in proportion to the rate of increase in the mileage of railways themselves and classification of the reasons therefor. Good practice in tunnel sections for steam and electric railways. Sections, lengths, grades, alignment, materials encountered, construction methods, progress, linings used, etc., of the Snoqualmie, Sandy Ridge, Seattle, Roger's Pass, and Covington tunnels, and the tunnels of the Grand Trunk Pacific Railway. Bibliography.

Treatment: Descriptive and analytical. Pages, 31. Illustrations, 19 line cuts and 4 half-tones.

Paper No. 84. Tunnels Recently Constructed in Italy.

By Dr. Luigi Luiggi; Luigi Cauda; Roberto Almagia and Guido Conti-Vecchi.

Subject Matter: Large number of important tunnels in Italy. Classification—(1) railway tunnels of great length, or which have presented special difficulties; (2) aqueduct tunnels of small section but of very

great length; (3) tunnels of very wide section for ordinary road traffic. Dimensions and comprehensive descriptions of ten tunnels. Under (1)—(a) Montorso Tunnel, 24,700′ long; (b) Vivola Tunnel, 24,400′ long; (c) Massico Tunnel, 17,650′ long; (d) Borlasca Tunnel, 13,200′ long; (e) Gattico Tunnel, 10,700′ long. Under (2)—(f) Capo Sele Tunnel, 15,250′ long; (g) Croce del Monaco-Ginestra Tunnel, 15,823′ long; (h) Murgie Tunnel, 16,021′ long. Under (3)—(i) Faro Tunnel, Genoa, 49′ 2″ wide; (j) Quirinal Tunnel, Rome, 50′ wide.

Treatment: Descriptive. Pages, 21. Illustrations, 8 line cuts, 1 halftone.

Paper No. 85. The Railway Tunnels of Switzerland, 1905—1915.

By R. Winkler.

Subject Matter: Distinction between "Principal" and "Secondary" Swiss railways; mileage. Topography of Switzerland; mileage of bridges and tunnels; tables of tunnels more than 2000 m. (6560 ft.) long. Comprehensive description of the construction difficulties, methods, appliances, progress, results and cost of the following Swiss tunnels: The Simplon Tunnels I and II; the Weissenstein Tunnel; the Ricken Tunnel; the Wasserfluh Tunnel; the Jungfrau Railway Tunnel; the Lötschberg Tunnel; the Tasna Tunnel; the Mt. d'Or Tunnel; the Hauenstein Base Tunnel; the Grenchenberg Tunnel. Legal enactments affecting the construction of railways and tunnels. Conclusions of the International Railway Congress at Bern as to tunnel construction methods and appliances. Organization and cost of construction; increase in rate of progress in past decade the result of improved organization and "scientific management". Comparison of some of the larger Swiss tunnels. Conclusions.

Treatment: Descriptive. Pages, 53. Illustrations, 1 sheet of profiles of tunnels over 2000 m. long.

Paper No. 86. American Railroad Bridges.

By J. E. Greiner.

Subject Matter: The development of American railroad bridges divided into three periods, first to 1865; second 1865 to 1890; third 1890 to 1915. The most important factors in the development in the third period—the increased weight of motive power and rolling stock, introduction of new construction materials, and the use of new and improved tools. The general standards of 1890 compared with those of today; the tendency is to substitute solid ballasted decks for open decks on short-span, beam and girder bridges and trestles; plate girders for short-span riveted trusses; riveted trusses for short-span pin-connected trusses; stiff bracing and counters for adjustable members; and the use of concrete and reinforced concrete masonry in place of cut stone work. The gen-

eral use of Cooper's standard loading, and American Railway Engineering Association specifications; types of locomotives in general use compared with Cooper's E-90.

Treatment: Descriptive and analytical. Pages, 28. Illustrations, 1 line cut and 17 half-tones.

Paper No. 87. Track and Roadbed.

By George H. Pegram.

Subject Matter: Work of A. R. E. A. and A. S. C. E. in standardization and tests. Essential features of modern railroad track; variation of details to meet different conditions; improvements in past decade. Table I: Track data, rail, ties, ballast, fastenings, wheel loads, etc., for 23 steam roads in 1915. Table II: same data for 15 electric railways. Plate I, cross sections of ballast and roadbed of 18 steam roads; Plate II, the same for 18 electric railways. Special forms of track for electric railways. Cross ties; wood, steel, treatment, etc. Fastenings, spikes and tie plate, with conclusions as to desirable practice. Rails; weight, section, axle loads, composition and rolling; experiences on various roads. Bibliography.

Treatment: Descriptive. Pages, 12. Illustrations, 2 folding plates.

Paper No. 88. Signals and Interlocking.

By Charles Hansel.

Subject Matter: The development of the track circuit and its application to the automatic block; difficulties involved in the use of track circuits for signaling on electric roads and reasons for the development and adoption of the alternating-current signal track circuit. Useless expense of heavy counter-weights necessary for the lower quadrant semaphore, and proof that by the adoption of upper quadrant semaphore the signal is made safer against the giving of clear signals when danger exists. The necessity of some form of automatic train control which will operate in the event of the failure of enginemen to observe visual signals; the several methods by which this end may be accomplished; requirements which must be fulfilled in order that system may be successful.

Treatment: Descriptive and analytical. Pages, 11.

Paper No. 89. Railway Terminals.

By B. F. Cresson, Jr.

Subject Matter: Deals principally with railway freight terminals. The general theory of terminal operation in America. Provision for assembly, classification and holding yards outside the congested district, intercommunicating belt lines and local distributing and receiving sta-

tions. The traffic capacity of railroads measured by the capacity of their terminals. Great expense of increasing terminal facilities, particularly in large cities, as compared with increasing facilities along the line. The elimination by the I. C. C. of competition in rates and terminal charges leading the railroads to seemingly unwarranted expense in improving and operating terminals. Multiplicity of individual railroad terminals, their advantages and disadvantages. Difficulties in establishing joint terminals; efforts now being made at several cities. Detailed descriptions and maps of the terminal situations at: New York, Chicago, Buffalo, Cleveland, St. Louis, and New Orleans.

Treatment: Descriptive. Pages, 37. Illustrations, 6 maps.

Paper No. 90. Recent Locomotive Development.

By George R. Henderson.

Subject Matter: The development along four lines—size, type, details and adjuncts. Increase in size necessitated by increase in weight and capacity of cars; increased size and capacity of locomotive secured principally by increasing length in order to avoid serious increase in wheel loads; increase in length, in turn, necessitated the adoption of new types of locomotives; various types described and illustrated. Improved construction materials and methods; cast steel; alloy steel; improved valve gears and boiler construction. Increase in power led to adoption of special devices and adjuncts to give more perfect control in operation; power reversing mechanisms; superheaters; power grate shakers; pneumatic coal pushers; mechanical stokers; fuel oil; coal dust.

Treatment: Descriptive and analytical. Pages, 20. Illustrations, 4 line cuts, 10 half-tones.

Paper No. 91. Rolling Stock Other Than Motive Power.

By Arnold Stucki.

Subject Matter: The development of competition in the improvements in rolling stock due to the elimination of competition in rates by reason of government rate regulation in the United States and Canada. Improvements along the lines of (a) safety and comfort of passengers, (b) strength and efficiency of construction, (c) efficiency in handling freight, (d) efficiency in moving trains, (e) protection of the freight. Steel cars; self-clearing and door-opening mechanisms; increased capacity and larger journals for freight cars; improved water-proofing and lining for cars. The work of the Master Car Builders' Association; list of standards adopted by the Association; items listed by the M. C. B. Assn. under "Recommended Practice". Continuing development of standards and special parts by individual manufacturers; air-brakes, couplers, lighting systems, draft-gears, brake beams, wheels, etc. Historical development of passenger train cars on different railroads; of flat cars; gondola cars;

hopper cars; coke cars; box cars; ore cars; tank cars; and of trucks and bolsters. Bibliography.

Treatment: Historical and descriptive. Pages, 55. Illustrations, 6 line cuts, 30 half-tones.

Paper No. 92. The Floating Equipment of a Railroad.

By F. L. DuBosque.

Subject Matter: Floating equipment required for passenger and freight terminal deliveries. The Hudson River ferryboat; means of loading and unloading ferryboats. Methods of delivering freight in New York City; conditions necessitating development of two types of car floats—pier floats and transfer floats; each type described. Transfer bridges; articulated type; automatic counterbalancing. Barges and lighters for the delivery of freight when transfer bridges are not available; house barges; self propelled barges; open derrick equipped barges or lighters; steam operated derricks; self propelled lighters. Tug boats; dimensions and equipment. Operation and control of the floating equipment. Methods of transporting coal to Manhattan Island; coal barges; "tows". Powerful tugs used in handling special type of car float used on Chesapeake Bay. Floating equipment necessary for one railroad in New York Harbor. Table of principal dimensions of various types of floating equipment.

Treatment: Descriptive. Pages, 12. Illustrations, 1 map, 26 line cuts and 1 half-tone.

Paper No. 93. Electric Motive Power in the Operation of Railroads.

By William Hood.

Subject Matter: Electrification of new lines and of existing lines; of steam-operated suburban lines with special locomotives and cars not adapted to main line service; of a mountain division of a steam road. The postponement of double tracking by electrification. Table of electric power required to operate mountain grades. The feasibility of a transportation company increasing the load factor by sale of power to other consumers. The relation of cost of power to actual power expenditure. Re-generation of power. The increasing cost of fuel and hydroelectric plants. Regulating laws as affecting railroad investment in electrification. Abandonment of electrification projects on account of the uncertainty as to the railroad's right to continue operation.

Treatment: Analytical. Pages, 6.

Paper No. 94. Electric Motive Power in the Operation of Railways.

By E. H. McHenry.

Subject Matter: The progressive development of electric traction; surface lines; interurban railways; subways and elevated lines; steam

railroads; tunnel lines; terminals; switching yards; long-distance and heavy trunk lines. Statistics of electrification of standard railways to September, 1914. Adaptation to traffic requirements; tendencies and future possibilities. Advantages and limitations of electric traction; elements of engine design; diversity of type; speed-torque control; axle loads; variable speed; induction; electrolysis and ideal engine characteristics. Economic conditions of application; yield on investment. Factors affecting earnings and expenses; train frequency and speed; acceleration; competitive conditions; track capacity; land values; legislation; economic basis of comparison; volume of traffic; assistant engine service; operation of yards, terminals and tunnels; engine fuel and repairs. Conclusion. Bibliography.

Treatment: Descriptive and analytical. Pages, 37. Illustrations, 7 half-tones and 2 curves.

MATERIALS OF ENGINEERING CONSTRUCTION.

Paper No. 95. Structural Timber in the United States.

By H. S. Betts and W. B. Greeley.

Subject Matter: Survey of the timber resources of the United States. Present draft on resources and possibilities in the future. Principal structural species of Southeast, Pacific Coast, New England and Lake States. Nomenclature, distribution, uses and characteristics. Factors affecting the strength and durability of structural timber. Necessity for grading rules; examples of commercial specifications and rules. Strength tests used by Forest Service. Relations indicated by tests.

Treatment: Descriptive and statistical. Pages, 50. Illustrations, 4 diagrams, 7 half-tones and 1 insert.

Paper No. 96. Timber in Canada.

By R. H. Campbell.

Subject Matter: Estimate of Canada's present total supply of commercial saw timber, with approximate land area covered. Detail estimates of timber and land area, together with annual cut and enumeration of different species of timber-producing trees for the following provinces: British Columbia, Province of Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick and Nova Scotia, Prince Edward Island.

Treatment: Descriptive and statistical. Pages, 11.

Paper No. 97. Indian Timbers Used in Engineering Construction.

By R. S. Pearson.

Subject Matter: Great number of species of trees due to wide range of latitude and altitude. Only eight species of greatest commercial im-

portance considered: Teak, Sâl, Deodar, Pyinkado, In, Gurjan, Kanyan and Andaman Padauk. Description of each species; distribution and growth; uses; production and value. Outline of history and present status of Forest Service in India. One quarter of British India now in reserves. Economics of timber trade; demand per capita for timber small; domestic supply just able to meet demand; improvement and development of forest resources to meet future increased demand.

Treatment: Descriptive and statistical. Pages, 15.

Paper No. 98. Timber of Russia.

By N. Tkatchenko.

Subject Matter: Forest areas; forest ownerships. The forests in the extreme north of European Russia; distribution of species, yield, mechanical properties and commercial uses, lumbering and management. The forests of other provinces of European Russia; distribution of species, mechanical properties and commercial uses, lumbering and management. The forests of the Caucasus; distribution of species, yield, mechanical properties and commercial uses, lumbering and management. The forests of Asiatic Russia; distribution of species, growth of trees, mechanical properties and commercial uses, lumbering and management. Organization and personnel of government forest service. Conservation policy. Export of timber. Brief bibliography.

Treatment: Descriptive and statistical. Pages, 24.

Paper No. 99. Preservative Treatment of Timber.

By Howard F. Weiss and Clyde H. Teesdale.

Subject Matter: Compilation of the best records on the life of treated timber. Status of the industry. Processes of preserving wood; superficial and impregnation; open tank and pressure. Life of treated timber in the United States. Preparation and treatment of timber. General conclusions. Appendices and tables.

Treatment: Statistical. Pages, 45. Diagrams, 3.

Paper No. 100. Clay Products as an Engineering Material.

By A. V. Bleininger.

Subject Matter: Factors governing the properties of clay products; intrinsic strength; strength of shape and molding structure. Classification of clays. Classification of clay products and consideration of their properties. Building brick; relation between intrinsic strength and structural strength; intrinsic strength of clay; compressive strength of bricks; brick testing and brick specifications. Brick piers; tests on actual columns by Howard and the Bureau of Standards. Porosity, resistance to weathering

and sudden heating and cooling. Paving brick. Hollow building tile and fire-proofing. Terra Cotta. Sewer pipe and drain tile; rule for thickness. Refractories; resistance to high temperature; load capacity; chemical analysis; thermal conductivity. Tiles and enameled sanitary ware.

Treatment: Descriptive and technical. Pages, 34. Diagrams, 4. One inserted table.

Paper No. 101. Concrete Aggregates.

By Sanford E. Thompson.

Subject Matter: Importance of concrete as a building material. General aim of paper the practical treatment of the fundamental principles involved in the selection of proper aggregates for concrete. Historical resumé. Aggregates of the United States. Requirements for concrete. Economy in selection of aggregates. Effect of the aggregate upon the quality of concrete and mortar; tests of quality; tests for acceptance. Wide variation in quality of aggregates. Fine aggregates should never be used until laboratory tests have shown satisfactory results. Characteristics affecting quality of concrete: (1) mineralogical composition, (2) specific gravity, (3) weight, (4) voids, (5) shape of grains, (6) coarseness, (7) gradation in size of grains, i. e., mechanical or granulometric analysis, (8) density of mortar or concrete, (9) impurities. Discussion of these qualities and significance with reference to desired characteristics. Special points: Coarse aggregate must be clean and hard; sand must be coarse or well graded and absolutely clean; vegetable and organic impurities particularly detrimental; a minute percentage of loam makes a sand absolutely unfit for use. Sand should always be tested for tensile or compressive strength in mortar, since it is absolutely impossible for the most experienced man to pass upon the quality of sand by inspection. Density of concrete mixtures with any particular material, assuming the same percentage of cement, is the most important characteristic for strength; conversely, the quantity of cement can be reduced and cost lowered by increasing the density of the mixture through scientific proportioning. Bibliography.

Treatment: Descriptive, expository and statistical. Pages, 26. Illustrations, 1 diagram and 10 half-tones.

Paper No. 102. Probable and Presumptive Life of Concrete Structures Made From Modern Cements.

By Bertram Blount.

Subject Matter: Early doubts as to permanence of structures built with Portland cement. Causes tending to destroy cement and consequently affect permanence of concrete structures; in ordinary concrete; in reinforced concrete. Causes internal to concrete itself: bad cement, now

possible to obtain cement free from inherent defects; bad aggregate; dangers to guard against—slag and coke breeze; bad proportions, mixing, workmanship, design. Causes external to concrete itself: so-called acts of God; ordinary wear and tear; action of fire. Chemical action; especially saline solution; destruction of cement; corrosion of reinforcement. Sovereign safeguard density and impermeability. Richness in cement and puzzolanic material necessary. Acid solutions—special cases. Electrolysis great danger to reinforced concrete in future; prevention of stray currents necessary. Internal stresses in reinforced concrete: due to corrosion of steel; to differences in coefficient of expansion, and wetness or dryness. Need of long time tests on full-size pieces.

Treatment: Descriptive and technical. Pages, 18.

Paper No. 103. Volume Changes in Concrete.

By Alfred H. White.

Subject Matter: A review of present knowledge of the volume changes in concrete, object of paper. Changes during initial hardening; apparent anomalies of contraction and expansion. Changes in concrete continually immersed in water. Changes in concrete kept continuously in air. Volume changes in neat cement when alternately wetted and dried; influence of humidity of atmosphere. Volume changes in concrete when alternately wet and dry. Effect of moisture on strength of concrete. Coefficient of thermal expansion of concrete. Effect of high temperatures. Effect of freezing. Effect of volume changes in concrete protected from the weather. Effect of volume changes in concrete exposed to the weather.

Treatment: Descriptive and technical. Pages, 31. Illustrations, 7 diagrams and 3 half-tones.

Paper No. 104. Waterproof Concrete.

By Richard L. Humphrey.

Subject Matter: General conclusions 24 in number. Necessity for waterproof concrete; waterproof a relative term. Materials added for waterproof should be investigated with regard to their effect upon the strength of the concrete, behaviour under changes of temperatures, effects on them of acids and alkalies, and their effect on the life and bond of embedded metallic reinforcement. Four general methods of attacking problem: (1) Proportioning, mixing and placing concrete to secure a maximum density, (2) plastering the exposed surface with a rich mortar (1 to 1, or 1 to 1½), (3) incorporating waterproofing material in the concrete, (4) an enclosed impervious seal to keep the water from the concrete. Practicability of securing waterproof concrete. Impervious concrete; conditions necessary. Concrete should be composed of dense

impervious aggregates with excess of cement thoroughly mixed with enough water to produce a viscous consistency, which may be conveyed without a separation of the aggregates and which can be tamped without bringing an excess of water to the surface. General results developed by experiments made in the Materials Testing Laboratories of the United States Geological Survey. Use of foreign materials in or on the concrete; integral compounds (powders), integral compounds (liquids), coatings, enclosed impervious seals. Workmanship and inspection. Cracks and construction joints. Examples of structures of waterproof concrete, 17 in number, with half-tone illustrations and brief description. Bibliography.

Treatment: Descriptive and expository. Pages, 47, Illustrations, 17 half-tones.

Paper No. 105. Use of Wood and Concrete in Structures Standing in Sea Water.

By Harrison S. Taft.

Subject Matter: Propagation and life of the teredo. Activity of the teredo and limnoria. Probable life of green piles subject to teredo attack; different kinds of wood used in dock piles; preservation of wood piles; amount of creosote treatment needed; life of creosoted piles; loads upon wooden piles, with suggested formula. General considerations regarding the use of concrete in sea-water structures. Cements; essential qualities of a cement suitable for a sea-water structure. Sand. Gravel and stone. Influence of temperature of water on character of resulting concrete. Use of salt water in making concrete water-proofing compounds. Mixtures and aggregates for use in salt water; method of mixing. Failures and frost action, with numerous citations of examples. Early applications of concrete for structures in sea water.

Treatment: Descriptive and expository. Pages, 39.

Paper No. 106. The Outlook for Iron.

By James Furman Kemp.

Subject Matter: Rise of the conservation movement; reserves of iron ore one of the chief subjects considered. Survey of progress of production in the United States and abroad and in some more important individual districts. Most marked growth in the United States subsequent to 1896, and due chiefly to Mesabi Range. Mesabi the key to maintenance of domestic supply at present grade. Yield of ores; in early days 60%; at present well down in the fifties; yield still declining and 35% not unreasonable as basis for looking ahead. Estimates of reserves; various points of view and assumptions; Lake Superior region; impossible to maintain output at present grade without new discoveries of rich ore; possible to maintain output definitely at thirty-five grade. Alabama;

conditions in a general way similar. Domestic supply of ore supplemented by importations from abroad. Brief survey of ore of principal countries shipping to United States; Cuba, Sweden, Norway, Newfoundland, Chile, Brazil, Europe and Africa. Relation of the supply of coke and coal to ore supply; fuel supply greater than ore supply, but coking coal less than coal for general fuel. Possibility of saving iron; scrap; improvements in smelting processes; economy.

Treatment: Descriptive, statistical and technical. Pages, 25.

Paper No. 107. The Life of Iron and Steel Structures.

By Frank W. Skinner.

Subject Matter: Paper deals chiefly with open-hearth mild steel in civil engineering construction in the United States. The life of a steel structure depends upon three fundamentals: the character of the structure, the service it performs, and the condition under which it serves. Most important types of steel structures. Classification of factors affecting deterioration; natural factors, artificial factors and dynamic factors. Deteriorating effect of natural factors; of artificial factors; of dynamic factors. Preservation of structures. Experience records and practice and opinions of experts: Corrosion; electrolysis; alternate wetting and drying; preparing steel surface for protection; painting and paints; other preservative processes; design; bridge stresses; overloading bridges; impact and vibration; fatigue; crystallization; locomotive blast and gas; effect of salt and acids; riveting; life of bridges; bridge accidents; comparative life of iron and steel; miscellaneous.

Treatment: Descriptive and expository. Pages, 75, with tables.

Paper No. 108. Alloy Steels in Bridgework.

By J. A. L. Waddell.

Subject Matter: Brief account of metals used in bridge work for past century. First use of nickel steel in Blackwell's Island Bridge. The author's investigation of International Nickel Company. Nickel steel proved to be reliable and in every way suited to bridge construction. Difficulty of securing nickel steel of proper characteristics from the manufacturers at moderate prices. Discussion of economics of nickel-steel spans vs. carbon-steel spans and mixed nickel- and carbon-steel spans. Practicable span length increased by use of nickel steel. Possibility of decreasing cost of nickel steel; use of ferro-nickel in the furnace charge; use of a natural alloy of nickel-chromium steel—Mayarí steel. Economic advantages of Mayarí steel. Present irregularity of composition and characteristics of finished products. Desirability of determining with certainty the structural value of both alloys. The author's investigation of "purified steel" by electric process in France. Steel corporations ex-

periments in this country. The author's paper on "The Possibilities in Bridge Construction by the use of High Alloy Steels". A proposed 3% aluminium alloy; Vanadium steel; use of Titanium; possible merits.

Treatment: Descriptive, technical and narrative. Pages, 35. Diagrams, 15.

Paper No. 109. The Economics of the World's Supply of Copper.

By Thomas T. Read.

Subject Matter: Uncertainty and difficulty of subject at the present time. Rapid increase in consumption of copper coincident with the development of electrical industry. Considerations affecting continued increase in the future; probability of substitutes for copper; possible changes in industry. World's resources of copper ore; United States; foreign countries; unexplored resources. World's copper trade.

Treatment: Descriptive and statistical. Pages, 8. Diagrams, 1.

Paper No. 110. The Place of Copper in the Present Engineering Field.

By Thomas T. Read and H. D. Hawks.

Subject Matter: Importance of copper in recent years and with special reference to the development of electric industries. Characteristics of copper which render it available for engineering and industrial use; ideal characteristics for a metal intended for the general service for which copper is used. Partial list of important items in engineering work and in industry made from copper. Copper wire used by telephone and telegraph companies, with approximate amounts of copper at the present time so employed. Copper as a factor in the electrical transmission of power. Copper wire and cable in general. Copper in electrical traction; copper as employed in steam railroad electrification in the United States, with tabular values of mileage and total quantities employed. Copper in the electric lighting industry. Copper in the automobile industry. Copper in boat and ship building. Brief reference to principal alloys based on copper. Heating and cooking devices. Building construction. Copper hardware. Copper coinage. Miscellaneous uses of copper. Ammunition and munitions of war. General conclusion, with diagram showing world's production of copper during the last 60 years and of aluminum during the last 25 years.

Treatment: Descriptive and statistical. Pages, 27.

Paper No. 111. Alloys and Their Use in Engineering Construction.

By W. Reuben Webster.

Subject Matter: Definition of alloys. Scope of paper—Brasses and bronzes. Brasses most important; variation of physical properties with

composition and treatment in manufacture; cold drawing and cold rolling; annealing. "High brass". Muntz metal. Extrusion process. Bronzes next important. Flux necessary for production of casting. Variation of physical properties with composition. Red brass; yellow brass; manganese bronze; copper-aluminium alloy; copper-nickel alloy.

Treatment: Descriptive and technical. Pages, 15. Diagrams, 7.

Paper No. 112. The Engineering Uses of Aluminium.

By Jos. W. Richards.

Subject Matter: Rapid development of the practical applications of aluminium in the past twenty-five years. Uses of aluminium dependent on physical and chemical properties. Uses based on physical properties; replacement of other metals on account of lightness; use as paint; use instead of copper for cooking utensils; weldability; applications in extruded shapes; conductivity for electricity as compared with copper; mechanical strength. Uses based on chemical properties; weathering; action of chemicals and foods. Light and strong aluminium alloys; with silver, copper, zinc, magnesium. Duralumin. List of uses of aluminium.

Treatment: Descriptive and technical. Pages, 17.

Paper No. 113. Testing of Materials.

By R. G. Batson.

Subject Matter: Static tensile tests; care necessary to reproduce conditions of actual practice; example. Fatigue tests; results of modern experiments. Combined stress tests; "Guest's Law". Impact testing; comparison of notched-bar tests with static tensile tests. Hardness and abrasion testing; definitions; instruments and methods based on definitions. Extensive bibliography.

Treatment: Descriptive and technical. Pages, 51. Illustrations, 8 diagrams.

Paper No. 114. Testing Full Size Members.

By Gaetano Lanza.

Subject Matter: Present status in the matter of testing full-size members. Meaning of term "testing full-size members". Importance of these tests. Need for well formed plan for carrying out these tests in order that results may be of value in engineering practice. Summary of the classes of full-size tests most frequently made at the present time; summary of full-size tests most needed; value of cooperation in carrying out the tests.

Treatment: Descriptive. Pages, 17.

Paper No. 114½. Notes on Corrosion in Iron and Steel Structures.

By Arthur T. Walmisley.

Subject Matter: Wrought iron versus steel where either might answer the structural requirements. Corrosion of cast iron. Electrolysis. Decomposition of cast iron pipes. Corrosion of wrought iron in sea water. Galvanized sheets. Protective coverings.

Treatment: Expository. Pages, 9.

MECHANICAL ENGINEERING.

Paper No. 115. Recent Advances and Improvements in Founding.

By Thomas D. West.

Subject Matter: General trend in the development of foundry practice. Intricacies of founding demanding special consideration. Installation, advantages and improvement of molding machines. The system most adaptable for the use of molding machines. Different methods adaptable for compressing sand by molding machines. Benefits of strata uniformity and reversibility of density in face of molds. Advancement in and results of "Jar" or "Jolt" ramming. Hard face and soft under-supporting body for "open sand molds". Necessity of hard rammed under-supporting body of sand for molds. Advantages of the reversible action of squeezer's methods in compressing sand. "Gravity" ramming and uniform density throughout the sand. Roller compression of sand and its distinctive features. Introduction and utility of power hand-ramming appliances. Improvements in jolt ramming of molds. Operation of plain jolt machines by means of cams. Shockless jarring machines to prevent transmission of ground waves. Combination jolt, roll-over and draw-the-pattern machines. Swing-arm, jar-ramming, turn-over, pattern-draw molding machine. Hand- and power-squeezer molding machines. Combination of jolt and squeezer methods for ramming molds. Construction of and methods for operating gravity molding machines. Construction and operation of the roller ramming machine. Improvements for mixing, screening and conveying sand. Value of unit systems for shaking-out molds, tempering and conveying sands. Operation of a unit shake-out, sand-mixing and conveying plant. Mixing sand heaps on the floor by machines. Grab buckets, mixing, conveying and packing sand. Influences endangering the success of future founding, and needed remedies.

Treatment: Descriptive and expository. Pages, 47. Illustrations, 2 inserts, 18 half-tones and 7 cuts.

Paper No. 116. Recent Progress and Present Status of the Art of Forging with Special Reference to the Use of Quick-Acting Forging Presses.

By A. J. Capron.

Subject Matter: General reasons for great developments in the past 10 years. Comparison of forging press and steam hammer: effect on material; manipulation of the forging; output; economy in working; absence of noise and vibration; capacity of press and equivalent power of hammer. Methods of driving press. Forging operations: description of a modern 600 ton press; examples of forgings. Special classes of work: tire forging, disc wheels, axles, cogging ingots, shell forging, general forgings and repair work. Conclusions as to the superiority of presses to hammer. Short bibliography.

Treatment: Descriptive. Pages, 18. Illustrations, 3 half-tones and 2 diagrams.

Paper No. 117. Forgings from Early Times until the Present.

By C. Von Philp.

Subject Matter: Different methods of producing forgings: hammering, pressing and squeezing, extrusion, die-casting, bending. Hammering: historical; die forging; swaging process. Pressing and squeezing: advantages; development of method; quality of work; hollow forgings; capacity of presses; presses for high speeds; squeezing in rolling-mill work; upsetting and heading. Extrusion of metal: description; advantages and applications. Die casting: development and applications. Bending: development and applications; methods used in bending armor plates. Handling of forgings; cranes; special turning rigging; "manipulator". Heating of forgings, precautions.

Treatment: Historical and descriptive. Pages, 13, with 6 half-tones in text.

Paper No. 118. Machine Shop Equipment, Methods and Processes.

By H. F. L. Orcutt.

Subject Matter: Comparison of general conditions in the United States and Europe: extension of "American" methods to Europe; output and quality; supply of high-grade mechanics contrasted, effect of same upon products; scarcity of American engineers with the practical training with relation to scientific management; general indifference to thoroughness of practical training; prevailing aims of workingmen. Improvements in machine tools: new "types" and detailed development; important improvements of design; single-pulley drive, feed change gear boxes, independent motor drives, ball and roller bearings, speeding up of idle move-

ments, provision for cutting and cooling fluids, lubrication, precision, rigidity, chain drive; influence of high-speed steel. Specialized machine tools: list of generally useful machines; most important recent advances; machines for external cylindrical, internal cylindrical, flat-surface and gear-teeth grinding; modern tooth cutting; automatic chucking; cutting-off grinding. Developments with marked influence on machine shop practice: use and influence of high-speed steel upon design as to increased speeds, faster feeds, greater strength and rigidity, use of cutting fluids; uses of the laboratory; selection, inspection and heat treatment of materials; examples of possibilities of use of alloyed metals; limit-gauge system; description, field and applications, method of introduction in shops. General shop equipment: effect of lighting, heating and ventilating, fittings and furniture, etc. Elements of machine-shop management; classifications in divisions and subdivisions; development of "scientific" management; commercial management.

Treatment: Descriptive. Pages, 17.

Paper No. 119. Machine Shop Equipment, Methods and Processes.

By E. R. Norris.

Subject Matter: Introduction of high-speed steels and reasons for delays incidental to their efficient use. Interest created by Mr. Taylor's paper. Development of high-speed steels; introduction of tungsten-chromium steels; "air hardening" steel of Mushet; changes in composition to date; research by users; tests of solid, butt-welded and welded tip tools, with comparative costs; applications; comparative tests of carbon and high-speed steels in punching sheet steel. Heat treatment of tools: modifications in apparatus and instruments; methods. Stellite: composition; characteristics; limitations due to forms supplied; method of tipping tools; tool holders; comparison of cutting speeds with high-speed steels; limitations in cutting. Machining with edged tools: lines of improvement; selection of special machines; practical example of manufacturing accurately finished steel shafts; specifications of material; comparison of machines for cutting-off; centering; rough-turning shafts for grinding; milling keyways; grinding. Milling: stream lubrication; continuous milling; spline miller; example of heavy milling. Drills and drilling machinery; advantages of high-speed drills; improvements in design; multiple drilling. Grinding and grinding machines: development of abrasives; comparisons of dry-disc grinding and milling; wet grinding; cylindrical grinding. File sharpening. Electric driving of machine tools: advantages; improvements in machine-shop electrical equipment; automatic control; alteration and improvement of existing machines by electrical control. Consideration of costs; equipment, buildings, management; necessity of high efficiencies to balance increased costs; value of demonstration.

Treatment: Descriptive. Pages, 29. Illustrations, 4 diagrams and 6 half-tones in text.

Paper No. 120. Automatics.

By Ralph E. Flanders.

Subject Matter: Definition: past and present application of term to machine tools; usage in American shop parlance. Automatic action applied to standard machine tools: punch press, "dial feed"; milling; vertical milling machine with continuously rotating table; modification of Lincoln type of miller; series of movements for which it may be set; Potter & Johnson machine with two work tables; drill presses, description; gear-cutting machine, development; cylindrical grinding machines. Automatic screw machines: introduction of "automatics" with the original Spencer automatic screw machine, description; modern machines of this type, English and American examples; Brown & Sharpe type; extension of field from making of screws to all varieties of small units, washers, pins, collars, etc.; Gridley automatic, field extended to studs, short shafts; multiple-spindle type, National-Acme, Gridley, Davenport. Notes on mechanism: forms of control; methods of changing feeds for different set-ups and different cuts for the same set-up; description of lay-shaft control. Automatic turret lathes: descriptions of Potter and Johnson, Gisholt, multiple-spindle type, Bullard "Multautomatic", Conradson, "New Britain". Automatic lathes: description of "Fay", "Reed-Prentice". Tendencies in design; steps of development; simple single-spindle machines, multiple-spindle idea; example of development in a large watch factory; example of grouping in one machine of unrelated operations. Contemporary practice in automatic machinery: stages of development; field in which the different types are most economically employed; engine lathe, hand-operated turret lathe and screw machine. Automatic machinery and the economics of manufacture: manufacturing on large scale, questions of demand, of standardization; disadvantages of system, necessity of keeping product free from changes, monotonous character of work; advantages from standpoint of workmen; opportunities for men of ability, for workmen with small originality; question of adapting the design of the product to the method of manufacture.

Treatment: Descriptive. Pages, 29, with 20 half-tones in text.

Paper No. 121. High Temperature Flames in Metal Working.

By H. R. Swartley, Jr.

Subject Matter: Consideration of fuel gases for "autogenous" welding, preference for acetylene used in combination with oxygen. Factors governing degree of flame temperature, calorific value and nature of products of combustion; influence of specific heat. Comparison of acetylene with other fuel gases; economic possibilities of acetylene when burned with pure oxygen. Working requirements—ease of production, safety in use, ease of application, high quality of work; requirements for welding; for metal cutting. Production of acetylene and oxygen: production of

acetylene, compression; production of oxygen, by fractional distillation of air, by dissociating water; development of the acetylene and oxygen manufacturing business. Development of metal welding processes; low-pressure type of oxy-acetylene blow pipe; high pressure welding torch. Theoretical consideration of the production of high-temperature flames: theoretical volumes of oxygen and acetylene required; chemical combinations; practical volumes required. Comparison of processes with acetylene under low pressure and under independent pressure. Strength of joint produced by "autogenous" welding; breaking strength, elongation, reduction of area; present practice. Comparison of European and American practice: European practice covers low pressure system only; development in U. S. A.; medium-pressure positive-mixture torch excels in this field; early applications, dissemination of knowledge, research along metallurgical lines; demonstrations, instruction by manufacturers of autogenous welding apparatus, trend of development in torches, welding of heavy sections. Cutting metals: discovery of process; jet of oxygen on previously heated steel; evolution of form of torch. Economic factors, low-cost gas supply and minimum consumption. Recent notable instances of substitution of method for more laborious and expensive methods. Applications of autogenous welding and cutting—field work, hydroelectric pipe lines, jewelry work, tube and pipe. Construction of industrial establishments for producing autogenously-welded tube, cylindrical metal containers, repair of steam boilers, stationary and locomotive boilers, superheaters, steel railway cars, products requiring finish and appearance, pipe joints, steel- and iron-plate working lines, bodies for motor cars, air ships, submarines and ship building. Further development in this country: efforts of constructors and designers; handicap of instruction facilities through schools as in Europe. Thermit and its applications: nature of process; source of heat; evolution of process; temperature produced; development by promoters; introduction into steam-railway work; economy of process; use in shipyard; use in steel plant; butt welding of pipes; joining of rail ends; use in foundry and steel works. Bibliography.

Treatment: Descriptive and statistical. Pages, 22.

Paper No. 122. The Internal Combustion Engine of the Year 1915. The Gas Power System. A Survey of Its Status in the Year 1915.

By Charles Edward Lucke.

Subject Matter: Development of the internal combustion engine: historical; introduction using gaseous fuel; adaptation to use with liquid fuels; to solid fuels by the development of small gas producers; development of the injection system of handling heavy liquid fuels; operation of small engines on blast-furnace gas; variety, difficulties and imperfections of service to which it was applied; period of design, development of gas power specialties.

Applications and influence upon the industries as shown by statistics: marine propulsion; automobiles and aeroplanes; rail transportation. Stationary field: situation regarding various sizes of engines; steam and electric motor competition; field for gas power; development of producer-gas heating equipment, need for development of producer gas illumination; developments necessary to compete with steam plants and electric motors; question of the necessity of large units.

Gas power system: principle; possibility of immediate extension, example in England; order of magnitude; dependency of future of the internal combustion engine upon the economy of fuel; gasification as an essential to efficient combustion; statistical review of present use and treatment of the general fuel supply.

Gas producers: importance in the gas power situation; reasons for slow progress; fixed-carbon gas producer, analysis of processes and structures, limitations of size, weight and space, lines of development; bituminous producer, fundamental differences between anthracites and bituminous coals, general problem of treatment, sub-problems; types; problems of designers.

Use of liquid fuels: methods of preparation for use in internal combustion engines; influence of oil refining upon the development of the liquid fuel engine; development of systems for the utilization of liquid fuel; carburetor system, vaporization, proportioning of air to fuel, problem of distribution of wet mixture; retarding influences in carburetor design; mixture making with heavier fuels than gasoline, misdirected efforts, development of the hot bulb engine, fundamental difficulties and limitations, lines of advance; injection system, methods of ignition, Diesel and semi-Diesel forms.

Tendencies in engine design: general, motor cycles, automobiles and aeroplanes, motor boats, gas tractors for road and locomotives for rail haulage, stationary.

Tabulated power and fuel statistics.

Treatment: Descriptive, expository and statistical. Pages, 80.

Paper No. 123. The Development of the Construction of Turbines in the Netherlands.

By D. Dresden.

Subject Matter: Historical: general lack of water power; early methods of draining polders; introduction of the steam engine; unfavorable manufacturing conditions; beginning of the manufacture of marine and stationary engines in 1830; effect of improved means of communication and the introduction of steam power upon the industries; effect of the introduction of the electric light. Development of turbine construction: selection of Zoelly turbine by Gebrs. Stork & Co. with view to manufacture; first turbines manufactured in 1906 from designs by Escher, Wyss & Co. of Zurich, gradual alteration of details; general description

as manufactured by Gebrs. Stork & Co., path of steam through turbine, prevention of steam loss and air leakage, bearings, lubrication, handling and attendance. Applications: driving generators; pumps for condensing plants; air compressors; high-pressure centrifugal pumps and direct-current generators for ship's use. Important points of development: for main sets; for driving accessory plants (and in plants using exhaust steam). Marine turbines.

History of oldest engineering works: Fyenoord at Rotterdam; "Werkspoor" at Amsterdam; "Schelde" at Flushing; and Gebroeder Stork & Co. at Hengelo.

Treatment: Descriptive and historical. Pages, 11. Illustrations, 2 line cuts and 1 half-tone.

Paper No. 124. The 1915 Steam Turbine.

By E. A. Forsberg.

Subject Matter: Development in Sweden: historical, DeLaval type, limitations; introduction of the modified Rateau type. Introduction of the Ljungström turbine; fundamental thought leading to its development; mechanical problems involved and their solution; general description. Firms representative of the present Swedish turbine industry. Recent development of DeLaval turbine; single-disc type, as to capacity, perfection of construction, available market, steam economy; multiple turbines of Rateau type, early unsatisfactory trials with turbine buckets and guide blades designed to transpose velocity energy of steam within them into pressure; advantages expected, economy of normal turbines, arrangements for combined power and heating demands; descriptions; examples and data relating to counter-pressure and tapping turbines. Ljungström turbines: circumstances contributing to good steam economy; problems of construction, temperature strains and axial pressures, successful solutions, disadvantage of dividing generator into two parts, small dimensions, experimental data showing record as to economy, sizes of units under construction, suitability for use with superheat; employment for marine propulsion, system used, description and data of comparative trials of two vessels, one fitted with reciprocating engines, the other with Ljungström turbo-electric drive. Probable future developments.

Treatment: Historical and descriptive. Pages, 17, with 3 diagrams in text.

Paper No. 125. The Diesel Engine in America.

By Max Rotter.

Subject Matter: Historic survey; Dr. Diesel's aims and experiments; introduction of Diesel engine in the United States. Types: comparison of Diesel and semi-Diesel engines; comparison of 2-stroke cycle and 4-

stroke cycle Diesel engines. Stationary Diesel engines; classification as to speed; comments on vertical and horizontal arrangements; double-acting engines. Structural details of vertical engines: "A" frames and enclosed crank case; cross-heads and guides; cylinders; admission and exhaust valves; fuel atomizers; method and mechanism of starting; piston and accessories; method and mechanism for regulation of amount of fuel to the cylinder; compression of air for atomizing and fuel injection; bearings; lubrication; exhaust headers and pipes. Fuels: consideration of various fuels; preference; heating value; minimum allowance of impurities; consumption. Descriptions of examples of American built engines: "Snow", Allis-Chalmers, McIntosh & Seymour, Fulton-Tosi of St. Louis, Dow-Willans, Fulton of Erie, Pa., Harris Valveless, Busch-Sulzer.

Treatment: Descriptive. Pages, 33. Illustrations, 20 line cuts and 3 half-tones.

Paper No. 126. The Boiler of 1915.

By Arthur D. Pratt.

Subject Matter: Factors influencing development; lines of recent development; tendencies towards use of high pressure steam; standardization of construction by legislation; increase of capacity, with illustrations and descriptions; securing higher efficiencies from heating surfaces. Factors bearing on modern high efficiency; truly mechanical features; continuous and automatic feed, progressive movement of fuel over grate and proper air admission, quick and automatic removal of refuse; furnace design; general and underlying principles of form; plant as a whole; labor saving from coal- and ash-handling machinery, low operating and maintenance costs, human factor, smokeless combustion; use of steel boiler casing. Increase of capacity: rating by heating surface; capacity of successive units in one of the largest modern plants; problem of obtaining high rates of combustion. Conditions in plant operation: ability to place boiler on the line quickly; economical handling of widely varying loads and continuous high overloads; consideration of possible overloads and average loads advisable; methods of handling loads; effect of feed water, furnace brickwork and draft upon point of maximum continuous overload. Furnace design for fuels other than coal: fuel oils; wood refuse; green bagasse; gaseous fuels. Utilization of waste heat: revision of ideas; use of gases of low temperatures, examples; high temperature gases. Value of intelligent supervision and use of continuous records. Superheaters: history; requirements for efficient operation. Heat transfer in steam boilers: recent published investigations; experiments of Mr. J. E. Bell, with formula for rate of heat transfer.

Treatment: Descriptive. Pages, 40. Illustrations, 6 line cuts and diagrams.

Paper No. 127. Equipment, Processes and Methods for the Boiler Shop.

By E. C. Meier.

Subject Matter: Important improvements during past 25 or 30 years: Early types of shops; building boilers for sea-going and lake vessels; locomotive boiler shops and boiler shops for river steam boats; improvements in equipment and methods due to marine and locomotive shops; early methods in jobbing and river shops; use of higher pressures, and the necessity for better workmanship and handling materials. Design and construction of shop for the Heine Safety Boiler Co. in 1900: consideration of arrangement; choice of location; general plan adopted; consideration of type of boiler to be constructed; location of railroad sidings to bring in raw materials; power house to produce electrical, steam, hydraulic and compressed-air power; erecting shop; storage of finished material; building for receiving heavy plates, tubes and other parts and to contain punches, shears, planers, and laying out tables; machine shop; sheet-iron shop and flange shop. Shop problems: internal transportation; routing the work in the shop; flanging by hydraulic machinery; study of heating processes; standardization; handling of misfits; avoidance of leaks in testing by drilling and reaming; high-speed drilling, with provision for lubrication; training of mechanics; storeroom; ticket system; riveting; testing; shipping department; piece work; summary; automatic machinery.

Industrial management: teamwork between departments; assurance of a "square deal" on the owner's part; personal welfare of men; reward for improvements; prevention of strikes; keeping track of individual material in each boiler; distinction between "boiler making" and boiler "manufacturing"; stock work; supplementary work; duplication of tools; inspections; weekly cleanings; storage of oils; annual inventory.

Treatment: Descriptive and expository. Pages, 16.

Paper No. 128. Compressed Air in the Arts and Industries.

By W. L. Saunders.

Subject Matter: General significance of compressed air in the arts and industries. Compressed air in metallurgy. Compressed air in marine practice, forced draft. Forced air circulation: blowing engines, ventilation. Air pressures in blast furnaces. Fans and rotary blowers. Pneumatic pressure in submarine work. The diving bell. Pneumatic air-lock and caisson. Pneumatic tunnel shields. Locomotives. Railroad air-brakes. Pneumatic despatch. Pneumatic gun. Torpedoes. Submarines. Transmission of power by compressed air. Centralized power plants. Efficiency of pneumatic transmission. Bibliography.

Treatment: Descriptive and historical. Pages, 16.

Paper No. 129. Safety Engineering.

By Frederick Remsen Hutton.

Subject Matter: Definition of safety in the sense used in paper. General subdivisions of safety engineering: (1) Accidents and safety apparatus to prevent them; (2) gradual disability and loss of wage-earning capacity resulting from occupational disease; (3) general; combinations of the above two; (4) betterment. Safeguarding the source of power; engine stops. Safeguarding internal transportation. Safeguarding at the individual tool, with numerous illustrations. Safeguarding the foundry. General conclusions.

Treatment: Descriptive and expository. Pages, 26. Illustrations, 11 cuts and diagrams.

Paper No. 130. Motor Vehicles; Passenger Type.

By Ethelbert Favary.

Subject Matter: Present day construction of various parts.

Engine details: stroke, stroke-bore ratio, speed; cylinders; casting en bloc; separate heads, advantages; number of cylinders, relative efficiency, advantages and disadvantages. Valves: diameter and location; comparison of practice with "L", "T" and "I" head motors; camshaft drives, spur and helical gears, silent chain; timing; poppet and Knight sleeve types, advantages and disadvantages, improvements. Pistons: length and weight; advantages of laminated rings. Connecting rods: advantages of alloy steel; I-beam section. Crank-shaft and bearings: number and length of bearings; advantages of stiffer crank-shafts. Operating details: cooling, comparison of systems, pump circulation, thermo-syphon, larger water jackets, air cooling, effect on fuel economy; fuel feed; comparison of pressure, gravity and vacuum feed; lubrication; splash, pressure and splash-pressure systems. Power transmission details: clutches, dry disc, cone, multiple disc, comparison; clutch brake; transmission, location and combined housing, planetary type, number of speed changes, gears, gear shafts; final drive, advantages of spiral bevel-drive, worm-gear drive; rear axles, semi-, three-quarter and full floating; "Hotchkiss" drive, elimination of torque and thrust rods, universal joints. Chassis details: axle bearings, for front wheels, for rear wheels and differential; front axles and steering mechanism, I-beam type, worm-and-sector type, worm-and-nut steering gear; springs, front suspension, semi-elliptic standard, rear, three-quarter elliptic favored, cantilever; chassis frame, recent tendencies and developments. Wheels: comparison of wooden and wire. Electrical details: ignition; magneto being abandoned; storage battery with electric generator for lighting, starting and ignition; single system of ignition; lighting and starting, single- and double-unit systems, double-deck system.

Treatment: Descriptive. Pages, 41. Illustrations, 32 half-tones in text.

Paper No. 131. Motor Vehicles; Utility Type.

By Arthur J. Slade.

Subject Matter: Recent standardization of commercial motor cars; storage battery electrically propelled vehicle; internal combustion engine driven vehicle: Each type has its own field of application: electric vehicle especially suitable for city service or where road surfaces are smooth and grades not excessive; internal combustion engine driven vehicle adapted for service where road conditions are less favorable or where unlimited mileage is required. Modern electric vehicle can cover 50 miles on single battery charge; gas car unlimited in mileage and performs work impossible by any other means of transportation and at lower cost. Both types manufactured in sizes ranging from light delivery cars to trucks of 5 ton capacity and upward. Change in weight distribution between front steering wheels and rear driving wheels. Use of alloy steels in reduction of weight. Protection of battery against admission of foreign substances. Electric wiring on electric vehicles. Storage batteries; standard number of cells in battery; standard voltages. Current consumption in watt-hours per ton mile. Types of engine for gasoline trucks; cylinder size as indicated by standard practice; trend of development in ratio of stroke to diameter. Transmission and type of drive. Brakes. Springs. General features of design for internal combustion engine trucks. Economic comparison of internal combustion engine and electric trucks. Commercial application. Utility and economy of trucks greatly improved by use of trailers. Trailers two types: 1st, 4 wheeled; 2nd, 2 wheeled or semi-trailer. Public service uses for motor trucks: passenger transportation. Public utility service; street cleaning, including refuse collection. Tendency regarding standardization.

Treatment: Descriptive and statistical. Pages, 23. Illustrations, 12 half-tones.

Paper No. 132. Motor Tractors.

By Frank S. Davis.

Subject Matter: "Tractor"—definition.

Early development: within the past 10 years, after the success of the internal combustion engine; inception due to desire to displace the steam traction engine; comparison; part played by the Western farmer; power of first tractors developed; application in the Middle West, in the East.

Influence of fuel on tractor development: Difference in fuel used today and in early machines; use of gasoline; heavy-oil burning type; grade of labor used; multi-cylinder types; types on market; use of kerosene, comparative consumption with kerosene and with gasoline, consumption at various loads.

Types of motors used on present day tractors: automobile motors and specially designed engines for tractor purposes; few four-cylinder

tractors in the "successful tractor class"; single and two-cylinder heavy-duty tractors have proved their claims; practically automatic action, heat regulation of the cooling system; 2- and 4-cylinder horizontal opposed type, 1, 2 and 4 cylinder horizontal type, 4 and 6 cylinder vertical type; discussion of types, lubrication, cross-mounting.

Tractor Construction: Frame; drive mechanism, spur gear drive, gear guarding, gear enclosed in gear case running in oil driving rear wheel hub by jaw clutched sleeves; wheels, spokes, extension rims, live rear axles; front axle and steering, pointed stub axle, solid "dead" axle; spring mounting; steering devices; materials; starting mechanism, hand and power starting.

Road Work: road hauling work and road making; road hauling, hauling grain; road making, cutting of new dirt, grading, regrading or leveling of old roads.

Agricultural Uses: preparing, cleaning or grubbing, etc., breaking, plowing, deep tilling, harrowing, disking, seeding, and rolling or packing; harvesting, threshing, ensilage cutting and silo filling, feed grinding, corn husking, corn shredding, corn shelling, sawing, and other belt work.

Present Status: Unsettled conditions, no real demand, present day successful tractor, comparison with the automobile industry.

Trend of Ultimate Development: Reason for great number of designs, types particularly suited for special purposes, should not try to make "jack of all trades" machines, trend already started along line of specialized machines.

Treatment: Descriptive. Pages, 25, with 2 line cuts and 10 half-tones in text.

ELECTRICAL ENGINEERING AND HYDROELECTRIC POWER DEVELOPMENT.

Paper No. 133. Economics of Electric Power Station Design.

By H. F. Parshall.

Subject Matter: Design from two points of view, mechanical and economical. Present paper primarily from economic point of view; guiding principle—the amount of capital that can be used in effecting any economy in generation is proportional to the number of hours in the year during which such economy can be realized. Diagrams showing total capital cost of modern power stations per kilowatt installed, thermal efficiencies which may be expected, fuel costs, total costs, capital charges, sum of operating and capital costs. Diagram showing final results in terms of relative total cost under varying conditions. Factors in designing motor power stations: selection of site, cost of cables, influence of varying economy of prime movers, influence of operating conditions on economy, economizer installation with discussion of saving, influence of load factor, and other conditions on installation of economizer. General

problem of auxiliaries and auxiliary power. Centralization on a large scale an economic necessity. Influence of character and quantity of service required.

Treatment: Expository. Pages, 26, with 22 diagrams in text.

Paper No. 134. The Electric Motor as an Economic Factor in Industrial Life.

By David B. Rushmore.

Subject Matter: The age of power. Advantages of electric-motor drive. Charts showing increase of power used in manufacturing since 1889. Statistical table giving summary of manufactures under various industries and including number of persons employed, capital involved, salaries and wages paid, cost of materials and value of products. Tabular statements showing power involved in electric motors in the leading manufacturing industries for the three years, 1899, 1904 and 1909. Miscellaneous tables showing horse-power used per person engaged in industry in various forms of manufacturing; also power used in mining, in street and electric railways and power generated in commercial and municipal central stations. Classification of motors and factors involved in their application under following heads: current, phases, frequencies, voltages, capacities, speeds. Classification of motors according to current. Classification of motors according to operating characteristics under following heads: series motors; shunt motors; compound motors; differential motors; synchronous motors; induction motors, phase-wound; induction motors, squirrel cage; synchronous-induction motors; A. C. Commutator motors. Load conditions. Motor rating and limitations. Mechanical design. Special types of motors. Control equipment. Economy. Fields of electric motor application. Outline of factors involved in the industry.

Treatment: Descriptive and statistical. Pages, 20, with 1 line cut in text.

Paper No. 135. The Influence of the Electric Motor on Machine Tools.

By A. L. De Leeuw.

Subject Matter: Special demands resulting from introduction of high-speed steel. Significance of individual drive for each important machine; influence of individual drive versus counter-shaft drive on shop design; development of portable machine tools, electric driven; the amount of power required by machine tools; beneficial influences of electric motor on machine tools under the following heads: (1) Better knowledge of the data governing design, (2) greater possibilities in regard to power, (3) closer control in regard to speeds, (4) flexibility, (5) influence of machine tools on design of electric motors. Investigation of power required, and all other operative conditions for machine tools much simplified by individual-motor drive. Variable-speed motors suited to the

requirements of machine-tool drive; use of mechanical speed-change devices; use of electric motor for auxiliary functions.

Treatment: Descriptive. Pages, 12.

Paper No. 136. Electric Welding.

By C. B. Auel.

Subject Matter: Three distinct processes for electric welding; namely, arc, incandescent, and electric-percussive. Arc method: Zerener process, Benardos process, Slavianoff process; temperature of arc; apparatus required; current used; methods of control; electrodes and holders; covering for operator; fluxes; filling material; procedure, flue welding; metals which can be welded; comparison of various arc processes; cutting of wrought iron and steel; other applications of the arc; opening of tap holes. Table showing costs for various typical applications; speeds of welding and cutting; strength of welds; methods of tests; tabular matter giving results of mechanical tests; conditions for metallic electrode welding; potential drop across arc; physical and chemical characteristics; direction of current. Incandescent welding: La Grange-Hoho process; Thomson process; list of metals, alloys and combinations which may be welded by Thomson process. Electro-percussive welding; description of apparatus required and method of use.

Treatment: Descriptive and statistical. Pages, 44. Illustrations, 13 line cuts and diagrams and 3 half-tones in text.

Paper No. 137. The Application of Electricity to the Heating of Metals.

By F. L. Bishop.

Subject Matter: Three methods for electric heating of metals: (1) passing metal through current to be treated; (2) passing current through a resistance material; (3) surrounding the metal with an alternating-current circuit so that eddy currents are produced in the metal, these currents generating the necessary heat. General description of first method. General description of second method, with reference to the Heraeus furnace, the Arsen vacuum furnace, the Muffle furnace, the Borchers furnace, the Watts furnace, the Sosman's carbon furnace, the Bailey furnace. Typical hardening furnace. General description of third method, with statement of advantages claimed for the method.

Treatment: Descriptive. Pages, 17, with 11 diagrams and 1 half-tone in text.

Paper No. 138. The Mechanical Problem of the Electric Locomotive.

By G. M. Eaton.

Subject Matter: General statement of problem. Sequence of events in crank-and-rod transmission. Maximum stress conditions: slipping wheels at maximum adhesion; running at maximum speed; running at

critical speed; brake application; flashing or bucking of motors; errors of assembly; collision, derailment, etc. Method for determining maximum stress. Maximum stress in U. S. practice. Polar diagrams. Discussions of diagrams: Type "A" locomotive—maximum speed; Type "A" locomotive—maximum adhesion; Type "A" locomotive versus Type "B" locomotive; Type "B" locomotive—maximum speed; Type "B" locomotive—maximum adhesion; Type "C" locomotive—maximum speed; Locomotive Type "C"—maximum adhesion. Bibliography.

Treatment: Descriptive and expository. Pages, 43, with 34 diagrams in text.

Paper No. 139. Effects of Electrolysis on Engineering Structures.

By Albert F. Ganz.

Subject Matter: Definition of electrolysis. Factors on which electrolysis depends. Electrolysis from alternating currents. Principal engineering structures subject to electrolysis: (1) Electric-railway tracks and structures, (2) underground lead-sheathed cable systems, (3) underground piping systems, (4) steel foundations of buildings, bridges, etc., and reinforced-concrete structures. General discussion of effects of electrolysis under these various headings: Status of electrolysis in Great Britain and Germany. Probable future tendencies in electrolysis mitigation: (1) Increasing the number of direct-current supply stations, thus reducing the radius for any one station; (2) increasing electrical conductance of track; (3) removing current from tracks by insulated return feeders; (4) Increasing resistance between tracks and earth. Bibliography.

Treatment: Descriptive and expository. Pages, 27.

Paper No. 140. On the Production of High Permeability in Iron.

By Ernest Wilson.

Subject Matter: Method of magnetic shielding. Description of method and tabular statement of results. The method of heat treatment: (1) alternating current; (2) continuous current. Method of operation and statement of results.

Treatment: Descriptive. Pages, 9, with 3 diagrams in text.

Paper No. 141. Electric Illuminants.

By S. H. Blake.

Subject Matter: Various forms and systems of electric lighting. Series open-arc lamp, alternating-current open-arc lamp, incandescent lamps, constant-potential arc lamp, enclosed arc lamp, series A. C. street-lighting system. European practice with reference to arc lighting. Nernst lamp. Open-flame arc lamp. Enclosed-flame arc lamp. Mercury vapor lamp. Quartz-tube or high-pressure mercury arc. Moore vacuum-tube

lamp. Direct-current series luminous arc lamp. Mercury arc rectifier system. Direct-current intensified enclosed arc. Osmium incandescent lamp. Tantalum incandescent lamp. Metallized carbon incandescent lamp. "Pasted" tungsten incandescent lamp. Neon vacuum tube. Drawn-wire tungsten incandescent lamp. Gas-filled tungsten incandescent lamp. Ornamental fixtures. Ornamental luminous arc lamp. Classification of electric illuminants relative to the character of the light-producing element; classification of electric illuminants relative to the production of the light entirely by incandescence or partially by incandescence and partially by luminescence. System of operation of incandescent lamps; effect of voltage fluctuation; effect of frequency; efficiency and life. Characteristics and systems of operation of arc lamps; temperature of arc; influence of cathode material; types of arc; volt-ampère characteristics of arc; arc on constant current; arc on constant potential; alternating-current arc; power factor; life. Candle-power comparisons. Tabular data indicating efficiency of commercial electric illuminants since 1878.

Treatment: Descriptive and statistical. Pages, 35, with 3 insert tables.

Paper No. 142. The Effect of Hydroelectric Power Transmission upon Economic and Social Conditions, with Special Reference to U. S. of America.

By Frank G. Baum.

Subject Matter: Brief survey of development of mechanical and other power as an aid to man. Hydroelectric power is end of long period of development. Most lasting progress made through use of other than human energy to obtain desired results. Growth of wealth due to use of mechanical energy; modern man is using energy stored up by nature; electric power is medium of exchange of mechanical power. Future of a nation's civilization will be measured in kilowatt-hours consumed per capita. Growth of electrical industry and effect of this industry upon the economic and social conditions of the people given in tables of statistics. Discussion of these tables. Large electric systems are to the advantage of the community as a whole. The stability of a country depends upon efficiency, and to be efficient it is coming to be recognized means to use electric power. Ease of transmission of electrical energy a great factor in the economic development of any community.

Treatment: Discursive and descriptive. Pages, 29, with 15 tables in text.

Paper No. 143. Electric Power in Canadian Industry.

By Charles H. Mitchell.

Subject Matter: Commercial supremacy of electricity as source of energy; electric railways, electro-metallurgy and electro-chemistry, munic-

ipal demands, electric power in industry, domestic-service load; telephony and telegraphy. Estimated total hydroelectric horsepower available in Canada. Power thus far developed according to province. Tabular data giving area, population, hydroelectric horsepower available and developed for principal countries of the world; graphical chart illustrating the same data. Influence of low cost of hydroelectric power. The hydroelectric commission of Ontario; brief sketch of the scope and character of its activities. The Niagara Falls' system. Tabular information showing lighting and power rates for principal cities in Canada. The Big Chute generating station. The Shawinigan Falls' system and transmission line. Graphical charts showing growth of miles of transmission lines, power loads and other characteristics of electrical power distribution.

Treatment: Descriptive. Pages, 28. Illustrations, 4 inserts, 2 half-tones and 7 diagrams in text.

Paper No. 144. The Water Power of Sweden.

By Sven Lübeck.

Subject Matter: General sketch of the available water-supply power of Sweden. Developed water power (principal installations). Future aspects of water-power development in Sweden. Government-owned water power. Description of certain large water power plants in Sweden: No. 1, Sydsvenska Kraft A. B. (South Swedish Power Corporation); No. 2, Trollhättan; No. 3, Haby; No. 4, Gullspång; No. 5, Dejefors; No. 6, Mockfjärd; No. 7, Bullerforsen; No. 8, Untra; No. 9, Älfkarleby; No. 10, Ljunga Works; No. 11, Finnfors; No. 12, Porjus. Legislation, governing authorities, and organizations concerning water power in Sweden.

Treatment: Historical and descriptive. Pages, 38. Illustrations, 6 inserts, 15 half-tones and 6 diagrams in text.

Paper No. 145. Canadian Hydraulic Power Development.

By Charles H. Mitchell.

Subject Matter: Factors influencing development: climatic and topographical; influence of engineers, manufacturers and financiers; lines of development during past 20 years. Water storage: seasonal changes in river flow; development as to the unregulated capacities of the rivers; storage possibilities; pondage; pondage and storage requirements. Government control: Dominion and Provincial. Description of several storage developments now under way or contemplated. Progress in hydraulic engineering: turbines, exciter arrangements, turbine speed control, water passages, surge tanks, water conduits, dams, relief valves, protection against flooding, log runs and fish ladders. Ice conditions: general effects of low temperatures; kinds of ice and troubles from same; selection

of power-house sites; blocking of iron screen racks; penstocks and turbine cases, protections.

Treatment: Descriptive. Pages, 28. Illustrations, 6 inserts, 7 half-tones and 3 diagrams in text.

Paper No. 146. Hydraulic Power Development and Use.

By J. D. Galloway.

Subject Matter: Principal consideration in connection with the generation of electric energy. Classification of plants as to head and type of water prime-mover employed. History and development of impulse water wheel; early application to driving electric generators; early examples of long-distance transmission; growth in size of units. Description and examples of equipment of medium- and high-head plants; storage reservoirs, diverting dams, conduits, regulating reservoirs, stand pipes, penstocks, valves and accessories. Examples of low-head turbine plants, situated at or near some fall, or requiring a canal or headrace. Discussion of station design: effect of tendency to increase transmission line voltage; evolution of electric machinery; medium- and high-head plants, low-head plants; choice of turbine or impulse wheel; variation in turbine design; comparison of use of vertical and horizontal shafts with impulse water wheels, with turbines; bearings; relief valves; rapid increase in size of units. Tabulated data of various early alternating plants, high-head plants, medium-head plants, conduit installations for medium- and high-head plants, recent low-head plants.

Treatment: Descriptive and statistical. Pages, 45. Illustrations, 3 line cuts and diagrams and 14 half-tones in text.

Paper No. 147. Developments in Modern Water Turbine Practice.

By H. Zoelly.

Subject Matter: Low-head water-power development: general description of early plants at Rheinfelden, Chevres, with vertical turbines, Wangen, Felsenau, Augst, and Laufenburg, with horizontal turbines; trouble from flooding of generator room floor; Unterbruck Power Station; Krauzberg plant; Kennelback plant, Austria; plant of Messrs. Gunther and Richter in Germany, installed above head-race level, method of starting; disadvantage of all above plants due to controlling mechanism working under water; ideal turbine; first improvement was increase of specific velocity of single runners of high output permitting direct connection to generators; plants at Keokuk and Cedar Rapids fulfill these conditions; same design adopted at Olten-Gosgen; proposed plant at Eglisau; main difficulties in design for sufficient capacities during floods. Medium-head developments: spiral Francis turbines, controlling mechanism originally in the water; Brillanne Power House, controlling mechanism changed; Messrs. Kellner Partington's installation; cylindrical casings, controlling

mechanism in water, examples; Francis turbines for 20,000 H.P. and upwards, reasons for same, example, advantages, design. High-head turbines: comparison of Girard and Pelton types; first high-pressure plant in Switzerland, designed with relief valves, examples; Pelton wheels with vertical shafts, examples; relief valves unsatisfactory for heads above 500 meters; deflecting nozzles with slow closure of outlet; governor control of needle and deflecting nozzle; deflectors; increase of specific speed; increase of ratio of diameter of jet to diameter of wheel; fixing of bucket to discs. Automatic speed governors: early methods, hydraulically operated governors; oil pressure governors, description, recent improvements, present tendency.

Treatment: Descriptive. Pages, 21. Illustrations, 7 inserts, 6 halftones and 4 line cuts and diagrams.

Paper No. 148. Wheels of Pressure Type.

By Arnold Pfau.

Subject Matter: Theoretical definition of wheels of the pressure type, by method adopted of transmitting the energy of the moving water to the wheel. Three specific types: (1) Girard or axial discharge action turbines, Pelton or impulse wheels; (2) so-called reaction pressure turbines; (3) "under-pressure" type. Classification according to direction of flow of water with reference to the shaft; radial outward discharge, diagonal outward discharge, axial discharge, diagonal inward discharge, radial inward discharge combined radial or diagonal inward axial and diagonal or radial outward discharge; historical notes with reference to each type. Applicability: displacement of all types of reaction turbines by Francis; of impulse wheels by the Pelton; principal characteristics of these types; meaning of these requirements; fields for each type; extension of field for Francis type. Classes and types: classifications of Francis turbines according to: characteristics of the runner, low, medium and high speed; the position of the shaft, vertical, inclined, horizontal; the setting, open flume and encased; the number of runners employed; the method of controlling flow, cylinder gate, wicket type or swivel gate, inside and outside types; problems of design, high speeds under low heads and low speeds under high heads; specific speeds, classification of Francis turbines under specific speeds, limits of heads for the types of this classification. Selection of type: factor dominant in early days to be avoided; basic conditions, comment on these conditions. Efficiency and tests: discussion of former and present efficiencies; testing laboratories, manufacturers, technical schools, Holyoke testing flume. Accessories: principal groups; means of shutting off the water under low, medium and high heads; means of controlling speed; requirements for satisfactory governors, mechanical, hydraulic, water or oil; independent control; remote control of governor; means for delivering compressed fluid; central oil pressure system, kind of oil; prevention of surges, typical cases; synchronous by-passes, conditions for proper regulation, operating diagrams; types of pressure regulators,

use of standpipes, surge reservoirs or air pressure chambers, differential surge-chamber. General remarks and suggestions: purchasing, testing, rating, nomenclature. Bibliography.

Treatment: Expository, mathematical and descriptive. Pages, 55. Illustrations, 16 cuts and line diagrams in text.

Paper No. 149. Water Wheels of Impulse Type.

By W. A. Doble.

Subject Matter: Introductory. Early development, mining period; later development, electrical period; general characteristics of construction. Wheel runners and buckets. Nozzles and systems of control. Governors. Main shafts. Main bearings. Wheel housings. Control gates. Baffle plates. Types of design; combination of various elements with reference to particular requirements; safety devices; load-limiting device; by-pass nozzles; multiple-jet units; typical efficiency curves.

Treatment: Descriptive. Pages, 56. Illustrations, 1 insert, 34 halftones and 3 line diagrams in text.

MINING ENGINEERING.

Paper No. 150. The Economic and Social Influence of Mining with Special Reference to the United States.

By William H. Shockley.

Subject Matter: Statistical matter relating to mineral products of the United States. Comparison of chief mineral products of the United States and of the world. Work of the United States Bureau of Mines. Chief characteristics of mining operations. Fraudulent mine promotions. Litigation. Characteristics of the Miner. A few notes on the history of mining. Races and racial changes in mines due to immigration. Statistical matter showing distribution of mining operatives among various nationalities for twelve selected mines. Living conditions of the miner. Increase of population in the United States. Accidents in mines; safety-first movement, welfare work, workmen's compensation act. Statistical matter relating to accidents and fatalities in mining operations. Labor unions; United Mine Workers of America, demands of miners, Western Federation of Miners, The Industrial Workers of the World. Strikes; early mining strikes, the Paint Creek strike, the Colorado coal strike of 1913-1914, Coeur d'Alène strike, Cripple Creek strikes, remedies for strikes. Future production of mineral fuels; coal, petroleum, natural gas. Future production of metallic resources with statistical matter; iron, copper, gold, silver, lead, zinc, phosphorus. Total value of minerals assessed annually in the United States. Bibliography.

Treatment: Descriptive and statistical. Pages, 66.

Paper No. 151. The Valuation of Metal Mines.

By T. A. Rickard.

Subject Matter: Basis of valuation of mining properties. Appraisals for mining properties in the State of Michigan for State taxation. Basis of valuation with reference to production of minerals: (1) The average cost of production; (2) the average price obtained for the product; (3) the future life of the mine. Valuation of mineral lands in Wisconsin. Basis of valuation of mines for sale or purchase: (1) the average yield per ton of ore; (2) the average cost per ton of ore (the difference between 1 and 2 is the "profit"); (3) the tonnage available now; (4) the tonnage likely to be available in future years. Methods required in order to determine average yield; methods available for determining costs and different interpretations of this term; measurements for estimates of present and future tonnage. Mining properties require minimum return of 7% on capital invested. General factors involved in planning for financial development of mining properties.

Treatment: Expository. Pages, 15.

Paper No. 152. The Valuation of Oil Lands and Properties.

By M. E. Lombardi.

Subject Matter: Introduction: growth and importance of the oil producing industry; valuation of oil lands compared with valuation of mines; statement of elements involved in valuation. Methods employed: the Pennsylvania method as applied in Eastern and Mid-Continent fields; conditions and practices in the Gulf Coastal fields; digest and comparison of two important valuations in California made in 1901 and 1914-15, showing change in practice. Study of the elements of valuation: the future of oil; methods of arriving at estimate of future production; estimating future costs of development; estimating future costs of production; discussion of importance of a development program; amortization, depreciation, etc.; the geologist and his sphere of work in relation to valuation. Application of data obtained to valuation; the weight to be given to each element studied, with illustrative equation. Bibliography.

Treatment: Expository. Pages, 44, with 2 line cuts.

Paper No. 153. Valuation of Coal Lands.

By Samuel A. Taylor.

Subject Matter: The valuation of virgin coal lands for investment purposes. Elements: (1) persistency of coal seams; (2) character of coal; (3) best available methods of mining the same; (4) transportation facilities and market. The valuation of coal lands for operating purposes. The valuation of coal lands for taxation purposes.

Treatment: Expository. Pages, 8.

Paper No. 154. The Valuation of Anthracite Mines.

By R. V. Norris.

Subject Matter: Anthracite coal mined chiefly in northeastern Pennsylvania, U. S. A., over an area of about 480 sq. miles: the Lehigh field; the Southern field; the Western Middle field. Early valuations. Assessment values for taxation. Royalty valuation. Valuation on basis of remaining tonnage. Valuation on basis of probable profits; influence of market conditions on valuation. Elements entering into mining costs of coal: thickness of measures, pitch veins, influence of depth, character of coal, gross output. Valuation based on condition of past history and future prospects. Treatment of improvements.

Treatment: Expository. Pages, 15. Illustrations, 1 insert and 4 line diagrams in text.

Paper No. 155. Evaluating Coal Properties in Western Canada.

By R. W. Coulthard.

Subject Matter: Estimate of content of Western coal beds of Canada under 4 subdivisions: anthracite and semi-anthracite, bituminous, subbituminous, lignite. Titles, royalties, etc. Geology. Quality of coal: sampling, analysis, physical properties, combustion tests. Section of measures. Extent of deposit: seams capable of present economic production; seams capable of future production; seams to be disregarded. Accessibility: transportation facilities; mine entry or entries. Plant requirements. Methods of mining. Cost of production. Plant site. Market. General remarks.

Treatment: Expository and descriptive. Pages, 10, with 1 insert illustrating methods of valuation discussed in paper.

Paper No. 156. The Coal Measures of France, Their Production and Future.

By Ed. Gruner.

Subject Matter: Location and extent of coal deposits in France. Coal bearing deposits surrounding the Central Massif: distribution, character, present production, probable future production, ultimate reserves. Anthracites and lignites.

Treatment: Descriptive. Pages, 11.

Paper No. 157. Workmen's Compensation and Mine Safety.

By Herbert M. Wilson.

Subject Matter: Progress made in direction of encouraging safety in industry generally. Recent inspections to the field of mining. Influence of technical inspection on elements of safety. Different types of accidents: falls of roof, rock, coal or ore; haulage accidents; shaft and slope accidents; electrical accidents; surface and shaft accidents. Causes

and preventive measures. Mine fires; gas and coal dust explosions; the dangers of inadequate ventilation; means of prevention. Danger of the improper use of explosives and of the use of improper explosives. Strongest ultimate influence toward safety in mining will come through education of owners and managers regarding value of the lives of their workers in view of liabilities involved under compensation acts.

Treatment: Descriptive and expository. Pages, 10.

Paper No. 158. The Functions and Work of Exploration and Development Companies.

By H. W. Turner.

Subject Matter: History of development companies. Proper function and work of exploration and development companies. Mining investments follow the flag: New York as a financial and commercial center; prospects of developments on the Pacific Coast centered in San Francisco. Prospects from the London point of view; views of American engineers on prospecting; views of a Canadian engineer regarding exploration companies. Flotation of mining companies. Mining laws and regulations of the United States and Alaska, the Philippine Islands, British Columbia, Mexico, Japan, Korea, Chinese Republic, Central America, Cuba, Colombia, Ecuador, Bolivia, Peru, Chile, Brazil, Argentine.

Treatment: Descriptive. Pages, 54.

Paper No. 159. The Financing of Mines in the United States.

By Lucius W. Mayer.

Subject Matter: Tabular showing of principal mineral products in the United States and in North America. American mining interests abroad; London as world's money center. Influence of the American mining engineer in connection with the developmet of mineral fields the world over. Tabular statement showing principal mines located in the United States which have paid dividends of not less than $5,000,000.00 each. Tabular statement giving principal American holding companies interested in mining, smelting and refining, with dividends paid to date. Proper protection of the investor. Publicity in mining. The cause of mining failures. Importance of good financiering. Different methods of development, organization and management of mining properties. Coal mining. Oil properties. Mining securities as investment. Brief summary.

Treatment: Historical and expository. Pages, 18.

Paper No. 160. European Mining Finance.

By J. L. Gallard.

Subject Matter: General introduction. The part played by European countries and their foreign possessions in connection with the world's

mineral production. The promotion of mining companies. Methods of financing mining enterprises. Limited liability companies. Mining and stock exchange. Mining prospectuses and public. Companies organized and promoted without prospectuses. Mining finance in other European centers. The future of mining finance. Bibliography.

Treatment: Historical and expository. Pages, 15.

Paper No. 161. The Organization of Mining Companies.

By William H. Shockley and Robert E. Cranston.

Subject Matter: General introduction. Organization of mining companies in mediaeval times. The acquiring of mines. Small mining companies. The raising of capital for mining operations. Symposium containing statement received from engineers to whom was sent circular letter containing 23 topics and questions relating to the organization of mining companies regarding which information was asked. Outline of the staff organization, by H. Foster Bain. Organization of Lehigh Coal and Navigation Company, by Edwin Ludlow. The exception principle as applied to graphic charts, by H. N. Stronck. Mine staff organization, by L. C. Uren. The organization and staff of the Juragua Iron Company, by De Bernière Whitaker. General discussion of relations with employees with reference to unions and strikes; remarks of Mr. Samuel Gompers on this subject. Scientific management with reference to its application to coal mining. Sociological department. Bibliography.

Treatment: Descriptive and expository. Pages, 58.

Paper No. 162. Relations of Governments to Mining.

By Horace V. Winchell.

Subject Matter: Mining and agriculture the two great forms of productive industry; extensive quotation from Dr. R. W. Raymond regarding importance of mining industry; products of mining in general less perishable than those of agriculture; gold and silver especially valuable as articles of export; sources of mining industry not perpetual; sources of mining industry less uniformly distributed among nations than those of agriculture. Historical references to early mining enterprises. Complicated system of jurisprudence governing the appropriation and use of minerals in different countries. United States produces roughly over ⅓ of the world's minerals. Tabular statement showing output of principal minerals in the United States and in the world. Quotation from report No. 694 by House Committee on Mines and Mining, submitted May, 1914. Mining, like agriculture, will be benefited by larger contributions from the Federal Government. The country's relation to its two great foundation industries, agriculture and mining. Tabular statement showing what the National government is doing for each of the two industries, agriculture and mining. Why the mining industry has received relatively so

little national aid. Special reasons why mining should receive larger national aid.

Treatment: Historical and expository. Pages, 18.

Paper No. 163. Mine Inspection.

By J. W. Paul.

Subject Matter: Purposes of mine inspection. Outline of comprehensive discussion of subject. Influence of compensation laws and insurance regulations. Government versus State regulation. Government inspection, purposes and methods. State inspection; work of the state inspector. Selection of state inspector. Tabular matter for the various states relating to the features of mine inspection service. General review of mine inspection; comment on laws of the various states; deficiencies in laws relating to coal mining. Insurance and insurance inspection. Mine fire insurance; mine fires. Liability insurance. Dangerous practices in mines. Company inspection; extracts quoting description of organization and methods and expressions of opinion from various companies operating systems of company inspection. Mine workers; organization of and relation to mine inspection; inspection by representatives of miners. Metal mining inspection and laws. Deficiencies in metal mining laws. Summary of characteristics of metal mining laws in various states. Tabular summary of inspection service in metal mining states.

Treatment: Descriptive. Pages, 28.

METALLURGY.

SYMPOSIUM ON IRON AND STEEL.

Edited by Henry M. Howe.

Paper No. 164. Iron and Steel Castings.

By John Howe Hall.

Subject Matter: Various commercial names for metals sold in the form of castings and coming under the class of iron and steel. Material and characteristics of steel castings. Malleable-iron castings. Cast-iron castings. Characteristics and adaptation of these different materials. Conditions affecting properties of steel castings. Influence of carbon on characteristics of steel castings; influence of silicon, manganese, phosphorous and sulphur. The annealing and heat treatment of steel castings. Influence of method of steel manufacturing upon characteristics of castings. Special and alloy steels. Methods for production of malleable castings. Specifications for malleable iron. Characteristics of material sold under the name of cast iron, semi-steel, gun metal, etc. Composition of iron used for castings of various sizes and characteristics. Electric

or blow-pipe welding of blow-holes and shrinkage cracks of steel castings. Difficulty of producing intricate forms in steel castings; need of special care in design of parts intended to be made of cast steel.

Treatment: Descriptive and expository. Pages, 12.

Paper No. 165. The Duplex Process of Steel Manufacture.

By F. F. Lines.

Subject Matter: As used in present paper term Duplex refers to a combination of the acid Bessemer and the basic open-hearth processes. Two general methods of operation described and compared. Number of blows required for one Duplex heat. Method of providing exact amount of carbon desired in final product; practical procedure. Losses in the Duplex process.

Treatment: Descriptive. Pages, 3.

Paper No. 166. Steel Making in the Electric Furnace.

By James H. Gray.

Subject Matter: General outline of process required for the manufacture of steel. Influence of objectionable substances, especially oxides. Application of the electric furnace to the making of steel free from objectionable elements including oxygen and sulphur; efficiency of the electric furnace in the elimination of sulphur. Recent growth in the use of the electric furnace. Reduction in cost of the electric process in recent years. Efficiency of electric furnace in making alloy steel and in melting alloy scraps without loss of the valuable alloy. Improved adaptation of steel to heat treatment. Combination processes involving use of older methods, using cheap fuel for roughing-down work and of the electric furnace for finishing or final refining. Possibility of the reduction in price of product as result of combination of Duplex or Bessemer open hearth processes with electric-furnace processes. Applications of electric furnace in Germany, Luxembourg and Eastern France. Recent installations of relatively large electric furnaces in the United States.

Treatment: Descriptive. Pages, 5.

Paper No. 167. Methods of Preventing Piping in Steel Ingots.

By Emil Gathmann.

Subject Matter: Character of solidification in a thoroughly deoxidized steel. Volume of liquid steel approximately 6% greater than solidified ingot. Sir Robert Hadfield's methods for preventing piping; method proposed by Mr. E. F. Kenney; method proposed by writer of paper, involving means of accelerating the solidifying of the lower

and body portion of ingot and by increased differential or lag in cooling of the upper portion of the ingot, providing liquid metal to supply uninterrupted feeding to compensate for the decrease in volume caused by the contraction or solidification of the lower and body portion of the ingot. Methods of realizing these conditions.

Treatment: Descriptive and expository. Pages, 4, with 1 line diagram in text.

Paper No. 168. Alloy Steels.

By George L. Norris.

Subject Matter: Carbon steel as distinguished from alloy steels. Metals commonly employed in making alloy steels. Ternary steels, with 1 metal alloyed, and quarternary steels, with 2 metals alloyed. General characteristics of alloy steels. Forging and rolling temperatures. Carbon content of alloy steels. Alloy steels for cutting tools. Hadfield's researches published in 1888. The development of high-speed steel subsequent to 1900; demands of the automobile industry. Alloy steel in bridge construction. Influence on alloy steels of the discovery of large deposits of vanadium in Peru. Most important alloy steels are those containing nickel, chromium and vanadium, singly or in combination. Manganese steel; Silicon steel; Nickel steel; Chromium steel; Nickel-chromium steel; Vanadium steel; Tungsten steel; Complex alloy steel. Table giving composition and principal physical properties of alloy steels for standard heat treatment with a draw-back temperature of 600 degrees centigrade.

Treatment: Descriptive. Pages, 10.

Paper No. 169. The Recent Progress and Present State of the Technical Application of the Case-hardening of Steel.

Subject Matter: Reasons for increasing demand for pieces of steel case-hardened and thermally treated. Present state of theoretical knowledge of case hardening. Characteristics of the various carburizing substances and their use: velocity and depth of penetration; cause of abrupt discontinuities; gradual "agents"; abrupt "agents". Technical conditions for the use of the various types of carburizing material: description of types of furnaces employed; character of box or container, method of packing and general technique of process; special features in the use of liquid and gaseous agents. Treatment and characteristic properties of cemented parts: ordinary carbon steel; nickel steel; chrome-nickel steel; illustrative examples showing character and influence of case hardening on armor plate, machine tools and miscellaneous machine parts.

Treatment: Descriptive and expository. Pages, 50. Illustrations, 19 half-tones and 6 line cuts and diagrams in text.

Paper No. 170. Metallography and the Hardening of Steel.

By Albert Sauveur.

Subject Matter: Metallography and the hardening of steel. Phlogiston theory. Percy's explanation in 1864. Akerman's compression theory. Howe's explanation in 1890. Early tension or stress theory. Osmond's allotropic theory. The stress theory, strengthened by André Le Chatelier and others. Le Chatelier's theory. Arnold's sub-carbide theory. McCane's interstrain theory. Humfrey's amorphous iron theory. Carpenter's and Edwards' twinning and amorphous iron theory. General conclusion that no theory so far presented fully satisfies the requirements for a scientifically acceptable explanation of the many phenomena involved. New avenues of approach needed in order to obtain a correct answer to the present enigma.

Treatment: Descriptive and expository. Pages, 8.

SYMPOSIUM ON THE METALLURGY OF COPPER.

Edited by E. P. Mathewson.

Paper No. 171. Progress in Copper Metallurgy.

By Thomas T. Read.

Subject Matter: General conditions of progress in the metallurgy of copper. Relative prominence at present time of hydro-metallurgical method as compared with blast-furnace smelting 10 years ago. Improvement in detail of operation of blast-furnace smelting. Development of conditions resulting in the use of reverberatory furnaces. Adaptability of hydro-metallurgical process to low-grade ores in a state of fine division. Probable use of H_2SO_4 as leaching solution and possibility of deriving this acid from sulphur in smelter fumes. Development of local wet processes for the extraction of copper from its ores.

Treatment: Descriptive and expository. Pages, 4.

Paper No. 172. Advances in Copper Smelting.

By Frederick Laist.

Subject Matter: Characteristic feature of improvement during past decade found in rapid growth of reverberatory as compared with blast-furnace smelting; principal reasons for this radical change. Application of reverberatory furnaces in the Anaconda district. Use of basic lining for copper converters. Conditions for successful operation of basic converters. Use of hot blast abandoned. Development and application of turbo-blowers. McDougall type of roasting furnace. Hall process for recovering silver from concentrates. Blast-furnace smelting: fuel oil versus coke for blast-furnace smelting; water-cooled types; pyrite smelting by the Knudsen system; bedding systems. Air-compressing machinery. Roasting and roasting furnaces. Reverberatory smelting and

types of furnaces available. Converters and converter practice. Bibliography.

Treatment: Descriptive. Pages, 14.

Paper No. 173. Copper Metallurgy of the Southwest.

By James Douglas.

Subject Matter: Brief historical sketch of the development of copper metallurgy in the Southwest. Principal changes made in the art of copper smelting during the past 33 years in the Southwest as illustrated by brief sketch of the development of plants and processes at the furnaces of the "Copper Queen". Replacement in recent years of the cupola by the reverberatory furnace. Furnace equipment of the various copper smelting works either completed or in the course of erection in the Southwest. Flow sheet of new plant of International Smelting and Refining Company near Globe, Arizona.

Treatment: Historical and descriptive. Pages, 8, with 1 line diagram.

Paper No. 174. Reduction Works—Copper Queen Consolidated Mining Co., Douglas, Arizona.

By Forest Rutherford.

Subject Matter: Condition of works in 1904. Character of material treated. Tests made in 1909 for determination of losses. Resulting changes and additions to plant: reverberatory furnaces, McDougall roasters, flues, dust chambers, and necessary general equipment. Further changes in plant resulting from changing characteristics of ore. Replacement of barrel type of converter with Great Falls type 12 feet in diameter; change from acid method of converter to use of magnesite brick. Increase of capacity from 2000 tons per day to 4500 tons per day. General adoption of reverberatory furnace process for treatment of fine materials; blast furnaces used for coarser materials only; method used to protect side walls of reverberatory furnaces.

Treatment: Descriptive. Pages, 4.

Paper No. 175. Advances Made in the Metallurgy of Copper, Globe District, Arizona.

By L. O. Howard.

Subject Matter: Recent improvements making possible the working of low-grade porphyry deposits. Recent enlargement in the plants of The Miami Copper Co. and the Inspiration Copper Co. General improvement in Globe districts dates from beginning of decade. Brief description of characteristic features of equipment, with method of work and results realized.

Treatment: Descriptive. Pages, 3.

Paper No. 176. Improvements in Design and Construction of Modern Copper Plants.

By Chas. H. Repath.

Subject Matter: Experimental work in the wet processes for the treatment of low-grade ores and tailings. Flotation methods for increasing recovery of the values in slimes. Improvements in the design of crushing and grinding machinery. Experiments to determine the valuable constituents other than copper and precious metals found in the ore and in the gas and flue dust incident to the operation of reduction works. Brief description of the "Washoe" at Anaconda. List of companies which have built new plants in recent years, with capacity in tons per day. The use of belt conveyors in transportation. Sampling works and importance of their function. Brief description of program of work at plants of the Calumet & Arizona Mining Co. and Arizona Copper Co. Electrical methods for the precipitation of dust. The Cottrell system. Smoke damage. Improvements in the construction of reverberatory furnaces. Brick bottoms. The use of waste-heat boilers. Improvements in blast furnaces; form and construction. Methods of charging furnaces. Handling of resulting matte and slag from glass furnaces. Experimental work in recovering heat from slag and its use in generation of steam or heating of air. Use of magnesite brick in linings. Treatment of silicious ores. Modern methods of handling copper. Importance of power in modern metallurgical processes. Factors entering into reduced characteristics of production. Bibliography.

Treatment: Descriptive. Pages, 19.

Paper No. 177. Leaching Copper Ores.

By W. L. Austin.

Subject Matter: Recent increase in attention given to treatment of copper ore by leaching method. Such methods available for treatment, in large quantities, of low-grade mineral unsuitable for economic treatment by other methods. Ores suitable for leaching. Choice of lixiviants; sulphuric acid commonly used as solvent in majority of cases, but other lixiviants also under trial. Lixiviation compared with other methods of ore reduction. Operations comprised in leaching: bringing copper into solution, separation of pulp from lixivium, recovering copper from solution, treatment of the deposited copper products. Crushing the ore. Roasting. Percolation and agitation compared; in large operations percolation given preference over agitation; continuous decantation used in handling slime. Strength of lixiviant. Fouling of solutions. The slime problem. Time required for bringing copper into solution. Percentage of extraction. Washwater. Removal of tailings. Dissolving the silver. Removing copper from solutions. Precipitation with iron. Chemical precipitation. Electrical deposition of copper. Composition of the elec-

trolyte. Electrodes. Electrolysis of copper sulphate solutions. Current conditions. Ore leaching vats. Miscellaneous apparatus.

Treatment: Descriptive. Pages, 62.

Paper No. 178. The Development of Electrolytic Copper Refining.

By Lawrence Addicks.

Subject Matter: Importance of electrolytic copper refining where ores carry sensible amounts of precious metals. First commercial experiments carried out at Phoenixville, Pa., in 1879; early difficulties in maintaining the purity of the electrolyte. Growth in tonnage refined by electrolytic methods since 1896. Three distinct stages in copper refining. Refining proper considered to begin with treatment of copper bullion of the grade of converter blister. Factors entering into lowering of production costs in modern methods. Furnace refining divided into charging, melting, rabbling, skimming, coking, poling, ladling and fettling. Structural improvements in furnace construction; use of magnesite. Electrolytic features of plant; character of power requirement; availability of steam engines for power, using steam formed by utilization of waste-heat. Tank-house arrangement; increase in size of anode; number of anodes per tank; current densities; improvements in construction of tanks; importance of nearly chemically pure anode; method of handling tanks for maintaining proper degree of purity. Production averages 6 to 7 lbs. of electrolytic copper per kw.-hr. Refining anode slimes.

Treatment: Descriptive. Pages, 7.

Paper No. 179. Electrolytic Refined Copper.

By A. C. Clark.

Subject Matter: Brief historical sketch of the development of electrolytic process for refining copper. Importance of electrolytic process in the separation of precious metals. From early small beginnings present production has grown to an annual output some 1,500,000,000 lbs. Table showing list of principal refining works with monthly output in pounds. Two systems employed, multiple and series; brief description of two systems, with diagrams. Early impurities in electrolytic copper; causes of irregularity and uncertainty of product; improvement in process resulting in modern high-grade product assaying 99.96% copper. Influence of arsenic on electrolytic conductivity of copper, with diagram. Methods of circulating electrolytic solutions. Increase in capacity of anode and cathode furnaces. Modern furnace linings; use of magnesite or chrome brick. Machine ladling. Waste-heat boilers. Diagrams showing increase in world's production of copper.

Treatment: Descriptive. Pages, 9. Illustrations, 4 line cuts in text.

Paper No. 180. Physical Properties of Copper.

By Carle R. Hayward.

Subject Matter: Industrial use of metal governed by physical properties and cost. Uses of copper in early times; modern developments with growth of civilization. Pure copper in the commercial sense: melting point; specific gravity; latent heat; coefficient of linear expansion; electrical conductivity; thermal conductivity; mechanical properties; gases in copper. Impurities of copper: effect of oxygen, arsenic, nickel, lead, bismuth, iron, antimony, silicon and phosphorus, manganese, sulphur, zinc, tin, aluminum, and other impurities.

Treatment: Descriptive. Pages, 24. Illustrations, 18 line diagrams and 8 half-tones in text.

Paper No. 181. Boronized Cast Copper.

By E. Weintraub.

Subject Matter: Theory involved in the use of Boroflux as a deoxidizer of cast copper. Boroflux defined as a material which contains boron in a state of oxidation below that of boric anhydride; compounds of boron available under this definition. Methods of use. Amount required. Efficiency of deoxidation illustrated by investigation by F. O. Clements. X-ray photograph showing porosity of ordinary cast copper and solidity of copper cast with aid of boroflux. Hardness of boronized copper. Boroflux as a deoxidizer for copper alloys containing lead, tin and zinc. Brief bibliography.

Treatment: Descriptive. Pages, 4, with 1 half-tone in text.

Paper No. 182. The Metallography of Copper.

By William Campbell.

Subject Matter: Effect of copper oxide on copper. Thermal diagram. Effect of silver, bismuth and aluminum on mechanical properties of copper containing arsenic. The structure of copper and the effect of cold work. The effect of hot work. Structure of electrolytic copper. Structure of wrought copper. Effect of mechanical work.

Treatment: Descriptive. Pages, 16. Illustrations, 15 half-tones and 4 line cuts in text.

Paper No. 183. Metallurgy of Copper in Japan.

By Rokusaburo Kondo.

Subject Matter: Early applications of metallurgy in Japan. The "Mabuki" smelting process. Smelting plants belonging to the Furukawa Co.: the Ashio Smeltery, location, history, ores, smelting process, pot roasting, briquetting, smelting, converting, treatment of smoke, blowers, power, transportation, workmen; the Ani Smeltery, location,

history, ores, smelting process, pot roasting, briquetting, smelting, converting, blowers, workmen. Copper works belonging to the Furukawa Co.: history; electrolytic plant in the Honjo copper works; the Nikko copper works; copper wire industry in the Nikko works; electrolytic plants of other companies.

Treatment: Descriptive. Pages, 17. Illustrations, 6 line cuts in text.

SYMPOSIUM ON THE CYANIDE PROCESS.

Edited by C. W. Merrill.

Paper No. 184. Coarse Crushing Plant; 1000 Tons Capacity.

By G. O. Bradley.

Subject Matter: Recent development in design and construction of crushing machinery. Classification showing type of crusher recommended for various characters of ores. Nature of information required in order to properly select crushing machinery. Description of design intended to illustrate discussion: conditions governing selection of design, flow sheet. Type of plant, capacity, material, equipment, product, power, construction, building, crushers, feeders, rolls, drives, automatic skips. Operation and control. Estimates.

Treatment: Descriptive. Pages, 8, with 4 inserts.

Paper No. 185. Crushing and Grinding.

By L. D. Mills and M. H. Kuryla.

Subject Matter: Primary crushing: trend of recent practice toward two-stage primary crushing, using first large size Blake-type or jaw crusher, followed by cone crushers to 2-in. ring; recent development of Symons horizontal-shaft disc machine for breaking from 4- to 6-in. ring down to 1- or 2-in. ring; representative figures showing cost of coarse crushing in average cyanide plants. Fine crushing or coarse grinding: the gravity stamp; tendency to supplant gravity plant with ball mills; practice of stamp crushing to finish product for cyanide treatment now practically obsolete; degree of fineness desired requires some form of attrition mill; tabular information relating to typical stamp mills. Fine grinding: tube mills; classification of finished products; cone classification; mechanical drag classifiers; substitution of steel or iron balls for flint pebbles; trial use of special polyhedron shapes; tabular information relating to typical tube mills. Chilean mills, giving data regarding use of same. Ball mills. Griffin mills. Grinding pans.

Treatment: Descriptive and statistical. Pages, 11.

Paper No. 186. Solution of Gold and Silver, Including Classification.

By M. H. Kuryla.

Subject Matter: Chemistry of the cyanide process; general considerations of solubility. Accessory treatment: amalgamation; concentration,

cost data for typical cyanide plant; general program of treatment; aeration; roasting; bromo cyanidation; wet desulphurizing. Slime agitation: thickening, continuous mechanical thickener; agitation, mechanical agitator, Pachuca (or Brown) agitator, Dorr agitator; capital costs of slime plants; cost of dissolution by slime agitation. Sand leaching: capital costs of sand leaching plants; operating costs of sand leaching plants, Rand, Homestake, Pittsburg Silver Peak. Filter slime treatment: Pittsburg Silver Peak; Homestake; capital cost of direct-filter slime-treatment plants.

Treatment: Descriptive and statistical. Pages, 20.

Paper No. 187. Filtration or Separation of Metal Bearing Solution from Slime Residue.

By L. D. Mills.

Subject Matter: Importance of separation or filtration as a factor in the cyanide process. Practical definition of the term slime. Practice in earlier days of the cyanide process. Factors involved in economic application of filtration and decantation methods. List of processes and machines now in general use for thickening, decanting and filtering slimes. Thickening. Vacuum filtration: the Butters filter, operating costs; the Moore filter, operating costs; the Ridgeway filter. Revolving drum vacuum filters: the Oliver filter; the Portland filter. Pressure filtration: Dehne type filter; the Merrill filter; the Kelly filter; the Burt filter. Continuous counter-current decantation: operating costs; intermittent decantation. Bibliography.

Treatment: Descriptive. Pages, 21.

Paper No. 188. Precipitation.

By G. H. Clevenger.

Subject Matter: Early attempts to effect precipitation from ore pulps upon metallic plate cathodes; unsatisfactory results; present practice contemplates precipitation from clear solutions only. Early types of clarifying devices; the Merrill clarifying filter process, costs of operation. Classification of various methods of precipitation used and proposed: electrolytic and chemical; electrolytic precipitation; various precipitants, charcoal, aluminum, zinc shavings, zinc wafers, zinc dust. Refining; methods and results. Bibliography.

Treatment: Descriptive and statistical. Pages, 35. Illustrations, 4 inserts, 6 half-tones and 4 line cuts in text.

Paper No. 189. The Smelting and Refining of Lead.

By H. O. Hofman.

Subject Matter: Introduction of blast-roasting; reverberatory furnace has become obsolete. Theories regarding blast-roasting; presence of

lime not absolutely necessary. Composition of charge; two rival processes in the United States, the Huntington-Heberlein and the Dwight-Lloyd; comparative advantages and disadvantages of the two systems. Form and proportions of blast furnaces. The Parkes process for desilverizing lead bullion; removal of bismuth from lead. Treatment of blast furnace matte. Formation of speiss in blast roasting. Formation of fine dust in blast-furnace work; filtration of fumes and dust; the Cottrell system of electric precipitation of fumes and dust.

Treatment: Descriptive. Pages, 5.

SYMPOSIUM ON THE METALLURGY OF ZINC.

Edited by Walter Renton Ingalls.

Paper No. 190. Some Main Points in the Economics of the Metallurgy of Zinc.

By W. R. Ingalls.

Subject Matter: Recent marked changes in the zinc industry of the world; introduction of the Wilfley table in 1896; introduction of Wetherill's system of magnetic separation and Blake's system of electrostatic separation for the treatment of mixed ores; introduction of flotation process of Broken Hill. Important consequences developing from the introduction of the flotation process. Characteristics of Broken Hill zinc ore. Importance of good workmen in metallurgical process. Installation of zinc smelteries in Australia, Siberia, India and Japan. Germany and Belgium as factors in the economics of zinc production. Principal districts of zinc smelting throughout the world. Systems of zinc smelting developed during the past 50 years. Brief historical sketch of important developments. American contributions to the development of zinc smelting. Comparison of European and American practice, developed in connection with sketch of principal operations in modern smelting practice. Economic results. Prospects for electric zinc smelting.

Treatment: Descriptive. Pages, 11.

Paper No. 191. The Development of Zinc Smelting in the United States.

By George C. Stone.

Subject Matter: Early production of spelter in the United States. Brief historic sketch of the development of zinc smelting in the United States. Developments in the East and South. Developments in the Mississippi Valley. Developments in the Missouri-Kansas coal fields. Developments in the Kansas-Oklahoma gas fields. Developments in Colorado. The Pittsburg district. Brief historic sketch of the development of zinc rolling mills. Developments in connection with processes for the manufacture of oxide of zinc. Development of methods for ore concentration. Types of smelter furnace developed in the United States; improvements

in roasting furnaces, ladle cars and miscellaneous features connected with the zinc industry. Various processes for making spelter. Electrolytic precipitation. Electrothermic smelting. Tabular information relating to spelter production in the United States and for the world.

Treatment: Historical, descriptive and statistical. Pages, 29.

Paper No. 192. Ore Dressing.

By Robert H. Richards.

Subject Matter: Early evolution in processes of dressing and concentrating ores. Flotation process; principles and methods of application. Magnetic separation; differential magnetic work on weakly magnetic minerals. Breakers and crushers; Chile mills; tube mills; stamps. Improvements in milling process. Recent flow sheets from Anaconda. Improvements in application of jigs, classifiers and flotation methods. Timber Butte mill, Montana, cited as illustration of advanced methods for use on complex ores, combining water concentration and flotation.

Treatment: Descriptive. Pages, 9.

Paper No. 193. Electrometallurgy.

By E. F. Roeber.

Subject Matter: Different effects or properties of the electric current which may be useful in metallurgy. Electric furnace processes: fundamental principles; classification of electric furnaces; applications of the electric furnace, melting and refining; reduction process. Electrolytic processes: fundamental principles; classification of electrolytic processes. Metallurgical application of the electrolytic processes: electrolysis with soluble anodes, electrolytic refining of metals—copper, silver, gold, lead, nickel, zinc, iron, tin, bismuth, cadmium; electrolysis with insoluble anodes—gold, copper. Electrolytic furnace processes: aluminum, sodium, magnesium, calcium, cerium, zinc. Bibliography.

Treatment: Descriptive and expository. Pages, 22.

Paper No. 194. Metallography.

By William Campbell.

Subject Matter: Recent broadening of the field of metallography. The structure of metals; the amorphous theory, strain disease, Quincke's "foam-cell" hypothesis; melting-points; critical points; physical properties, Tungsten. Binary alloys: thermal diagrams, copper-zinc. Copper-tin, copper-aluminum, aluminum alloys. Heat treatment, annealing, properties at high temperatures, etc. Ternary alloys. Electrical properties. Magnetic properties. Corrosion. Sulphides, etc. New applications of metallographic methods.

Treatment: Descriptive and expository. Pages, 12.

Paper No. 195. Symposium on the Utilization of Fuels in Metallurgy.

Edited by C. H. Fulton.

PULVERIZED COAL IN REVERBERATORY FURNACES.

By D. H. Browne.

Subject Matter: Use by the Canadian Copper Co. in 1911 of pulverized coal in reverberatory furnaces; size and character of furnaces. Experience during the years 1912-13; changes in design as result of experience. Economic results realized with improved design and construction.

BURNING PULVERIZED COAL IN COPPER REVERBERATORIES.

By E. P. Mathewson.

Use of pulverized coal in Garfield plant of the American Smelters Securities Company and the Washoe Reduction Works of the Anaconda Copper Mining Company in 1914. Physical characteristics of coal adapted for pulverizing. Fineness of pulverization necessary. Advantages and economic results anticipated.

GAS PRODUCER DEVELOPMENT.

By Z. C. Kline.

Recent tendency in furnace development has been toward regenerative and recuperative types. Importance of gas producer in view of decrease in natural gas production. Development toward mechanically-operated types. Demands for gas producer which will gasify bituminous coal and fix the tarry constituents. Mechanically operated producers more expensive in first cost and in upkeep, but for labor required, very much cheaper. Such producers furnish more uniform product and handle larger quantity of coal per square foot of surface. Probable future trend of development in gas-producer design, construction and operation.

SURFACE COMBUSTION (WHAT IS IT?).

By C. E. Lucke.

Chemical requirements for perfect combustion. Necessity of avoiding conditions furnishing possibilities of explosive combustion. Localization of combustion zones. Methods of preventing "back flash" and "blow off". Early work of Prof. C. E. Lucke led to discovery of fundamental principle governing surface combustion; later work of Prof. W. A. Bone, especially in the use of bonded diaphragms as fire beds. Introduction of the term "surface combustion" to distinguish this form from the usual free combustion.

Treatments: Descriptive. Pages, 7.

NAVAL ARCHITECTURE AND MARINE ENGINEERING

Paper No. 196. Calculations for Ships' Forms and Light Thrown by Modern Experiments upon Resistance, Propulsion and Rolling of Ships.

By D. W. Taylor.

Subject Matter: Calculations: discusses desirability of using mathematical formulae for ships' forms to facilitate preparation of lines. Describes methods developed and used at United States experimental model basin with mathematical derivation of formulae in appendix to paper. Resistance: present accepted ideas based upon results of model experiments initiated by William Froude and now in general use; minute accuracy not possible at present time, but resistance data for models of widely varying forms enables competent naval architects in most cases to determine resistance in advance with sufficient accuracy for practical purposes; variations of surface friction with temperature of water in model basins; influence due to fouling with marine growths. Propellers: Model Basin methods usually considered applicable to propellers, but fail at times by reason of cavitation; limit at which full-sized propellers begin to cavitate not clearly known; comprehensive formulae for power and efficiency of propellers derived from Model results; illustrates conditions in which a propeller works behind ship by giving wake currents at stern of model as measured and indicated by new method; description of device and method of use. Rolling: renewed interest in rolling of ships in recent years; brief historical sketch beginning with Wm. Froude's theory of 1861; discussion of agreement between Froude's formulae and results obtained with models; actual rolling curve for large battleship. Appendix II gives method of analysis of rolling curves for models, and concludes that results do not strictly agree with either Froude's or Bertin's assumptions regarding resistance of water in rolling.

Treatment: Mathematical, descriptive and expository. Pages, 67. Illustrations, 3 inserts and 15 cuts in text.

Paper No. 197. Ocean Freighters.

By Ernest H. Rigg.

Subject Matter: Experimental work justified; new rules replace old. Classification societies; Lloyd's register premier. Definite standard of strength a necessity; structural materials; structural standards not adapted to ship construction. Safety at sea. Bulkhead sub-division. Life-boats. Fire alarm and extinguisher systems. Improved accommodations for crew. Freighters classified; discussions; types; construction; longitudinally framed ships. Cooled and refrigerated cargoes; growth of frozen meat trade; effect on passenger liner's menus. Radio telegraphy. Elimination of wood decks. Influence of Panama Canal; American

Hawaiian S. S. Co.'s vessels; new designs contemplated. Effect of terminal facilities. Rapidity of dispatch. Improvement in crew's quarters. Lumber steamers. Use of fuel oil influences design. Changes in motive power. Propeller problems. Hydro-electric steering gear. Handicaps, patents, yard standards. Effects of U. S. navigation laws. Beginning of period of increased activity. Effect of submarine tactics. Bibliography.

Treatment: Descriptive. Pages, 20.

Paper No. 198. Recent Developments in Japanese Ship-building.

By S. Terano.

Subject Matter: General discussion of status of shipbuilding in Japan; brief historical sketch; condition of Japanese shipbuilding at the time of the Chinese war; commercial and shipbuilding expansion following upon conclusion of Chinese war; influence of war with Russia on Japanese shipbuilding. Governmental acts for the encouragement of shipbuilding; tabular and graphical information showing increase in tonnage during the years 1897-1915, and also tonnage built in each of the principal shipyards during the same period. Influence of present European war on Japanese shipbuilding; table showing number and gross tonnage of merchant vessels built at principal Japanese shipyards; brief review of development and increase in Japanese naval construction during same periods. Tabular information showing number and displacement of war ships launched each year during period 1891-1915; also tonnage built under various classes and types of vessels in mercantile yards during period 1897-1915. Development in the use of steel in warship construction. Extension of facilities for construction at rapid rate. Scarcity of skilled labor. Shortage in iron and steel structural material. Estimate of plant for the manufacture of armor plates in 1902. Increase in steel-casting foundries. Works for the manufacture of anchor and chain cables. Brief description of recent Pacific liners built for the Japanese-San Francisco service, with principal dimensions and technical characteristics.

Treatment: Descriptive. Pages, 21. Illustrations, 3 diagrams in text.

Paper No. 199. Bulk Freight Vessels of the Great Lakes.

By Herbert C. Sadler.

Subject Matter: Cargoes and handling: staples, iron ore and grain eastward, coal westward; tonnage; short season. Dispatch in loading and unloading, effect on design; handling facilities; grab bucket, Hulett bucket, elevated bins; time of loading and unloading ore; installations illustrated. Effect of handling methods on design: clear decks, spacing of hatches, depths of vessel, holds free from obstructions. Other influencing features: draught, depth of water, Sault Sainte Marie, Lime Kiln Crossing; length and breadth limited by locks, channels, harbors;

speed. Structural features and forms illustrated. Machinery: Scotch boilers, engines, Howden draft system, condensers, pumps. Trial particulars.

Treatment: Descriptive. Pages, 13. Illustrations, 5 diagrams and 5 half-tones.

Paper No. 200. River, Lake, Bay and Sound Steamers of the United States.

By Andrew Fletcher.

Subject Matter: Drawings more instructive than detailed description. Selections largely of steamboat type; extreme shallow-draft and stern-wheel steamers omitted. Sources of information. Selections include many well known steamers: "Washington Irving", "Berkshire", "Northland", "Seeandbee", "Horicon", "Tacoma", "Rose Standish", "Priscilla", "Commonwealth". Hull details: few built under Classification Rules; observance U. S. Steamboat Inspection Rules exacted; single bottoms; double bottoms; flanging vs. angle bars; longitudinal trussing; truss framing; deck beams; guard beams; guard braces; sponsons; main-deck plating; bulkheads; compartment exits; pumps; bitumastic compositions; elimination of wood. Machinery: engines; valves and gears; air pumps; condensers; main auxiliaries; feed-water heaters; filters; twin-tanks; boilers; fuels. Superstructures: generally wood with steel girders and pipe stanchions; fire bulkheads; slow-burning materials; all-steel impracticable; modernizing and refining; heating, ventilating, plumbing and sanitation. Sprinkler systems and other fire protection.

Treatment: Descriptive. Pages, 10. Illustrations, 44 inserts and 13 half-tones.

Paper No. 201. Special Types of Cargo Steamers for the United States Coast-to-Coast Trade Through the Panama Canal.

By George W. Dickie.

Subject Matter: Controlling factors. Cargoes. Compromise type. American Hawaiian S. S. Co. freighters. Desired features. Resultant construction. Outlines illustrated. Uses discussed. Methods of propulsion. Capacity. Draft. Refrigerated space. Double-bottom arrangement. Number of hatches. Handling cargoes, methods in use and proposed. Special type of vessel demanded.

Treatment: Descriptive and expository. Pages, 11, with 4 inserts.

Paper No. 202. The Development of the Sail Yacht, Steam Yacht and Motor Yacht in American Waters.

By William Gardner.

Subject Matter: The sailing yacht: early characteristics; "America", 1851; success resulted in distinct type, examples; center-board type,

characteristics, speed results, now extinct; "Madge", 1881, features, success, influences on designs; New York and Seawanhaka-Corinthian formulae; "Genesta", "Puritan", "Mayflower", "Volunteer"; 40-ft. class, "Minerva"; 46-footers, new principles, "Gloriana", "Dilemma"; changing rules; present rule, results satisfactory. The steam yacht; developed since 1890; harbor influences; three types, express, coastwise yachts, and sea-going cruisers; characteristics; Lloyd's rules; boilers, Scotch, water-tube; engines. Motor yachts: first marine naphtha engines, 1885; early history; Otto, Daimler, four-cycle, two-cycle, Riotte; recent development; high-speed or family types; "Pioneer", hydroplane features; monoplane type; raised-deck cruiser. Fuel controlling factor in future. Diesel engines.

Treatment: Descriptive and expository. Pages, 27. Illustrations, 6 inserts, 1 half-tone and 5 diagrams.

Paper No. 203. The United States Lightvessels, Nos. 101 and 102.

By George C. Cook.

Subject Matter: Principal dimensions and technical characteristics of Lightvessels Nos. 101-102. Lines of vessel are development of many years' observation on performance of these small vessels used as signal-light platforms when moored at sea. Vessel construction throughout of steel. Other fire-proof materials. General arrangement of hull and description of subdivision of internal space. Brief description of propelling power and auxiliaries. Mooring anchors. Brief description of signal-flash apparatus and fog-signal apparatus. Brief bibliography.

Treatment: Descriptive. Pages, 5. Illustrations, 6 inserts, giving lines, general arrangement, drawings and technical characteristics of vessels.

Paper No. 204. Warships of the First Line of Battle.

By E. Ferretti.

Subject Matter: Generalities: dreadnaughts, ships of the line, cruisers, scouts, destroyers and submarines; paper restricted to discussion of evolution in warships of line and in cruiser types; increase in size approaching limit on account of capacity of harbors, docks and yards and manageability. Gun armament: size and number increased; location; secondary armament, development; light guns. Armor: development and methods discussed. Underwater defense: lack of development; lack of data; chain nets, countermining, longitudinal bulkheads, outboard filling, third internal skin, multiplication of transverse bulkheads, provisions for escape of gas. Speed increased. Probable lines of future development; radio telegraphy and aerial navigation; ships may be reduced to two types, ships of the line, torpedo boats and submarines; six funda-

mental principles suggested and defined; public interest; heavy cost. Practical example: structure and arrangements, internal and external; guns and munitions; protection; propulsive machinery; speed and radius of action.

Treatment: Descriptive and expository. Pages, 26, with 3 half-tones and 1 diagram in text.

Paper No. 205. The Submarine.

By R. H. M. Robinson.

Subject Matter: Present general interest; historically old, practically new; paper limited to present day submarines; engineering problems and solutions. Essential qualities: seaworthiness, increased surface speed, greater submerged speed and radius, increased armament. Hull: form, reserve buoyancy, stability. Armament: torpedo tubes, more required, space provisions; capping; high submerged speed; guns, small calibre prevalent type. Propulsion: surface propulsion, oil engines, power; steam, development, boilers, oil fuel, turbines, difficulties; electric propulsion; submerged propulsion. Batteries, motors, gassing, noise. Periscopes: description; range finder; use of more than one; replacing. Special features: bottom wheels; diving compartments. Signalling: somewhat deficient in sight, hearing, signalling ability. Strength and stability. Anti-submarine provisions: external to object attacked; aeroplanes, tenders; contained within the object attacked, speed and handiness, nets, structural provisions. Submarine a tried and proven weapon of war. Table giving essential data regarding submarines of leading nations.

Treatment: Descriptive and expository. Pages, 15, with 1 insert table.

Paper No. 206. Submarine Torpedo Boats.

By L. Y. Spear.

Subject Matter: Modern submarine first entered active phase of development at beginning of Russo-Japanese war in 1904; submarines played no important part during this war; principal naval powers, however, continued construction and development. Number of submarines possessed by principal naval powers at beginning of present European war. Brief reference to submarine construction in Europe during present war. Principal types and distribution among principal naval powers. Distinction between submarines and submersibles. Single- and double-hull types indicate present trend of design; principal characteristics of these types. Diving and even-keel submarines. The principal features of design: size; habitability; armament; reserve buoyancy; speed; cruising radius. Power equipment for surface cruising: advantages of Diesel engine under following heads—(a) compactness and moderate weight;

(b) economy in fuel consumption; (c) ability to start instantly; (d) ease in disposition of products of combustion; (e) freedom of excessive radiation or storage of heat; maximum sizes at present available; weights of Diesel engine per brake horsepower; rotative speed. Power and equipment for submerged cruising: advantages of storage-electric-battery drive under following heads—(a) weight of plant remains constant while in operation; (b) no evolution of heat while running submerged; (c) motors are silent and free from vibration. Disadvantages of storage battery power under following heads— (a) fragility and lack of durability of storage batteries; (b) danger arising from hydrogen-oxygen gases given off; reference to different types of batteries, including recent Edison nickel-iron alkaline cell. Lessons from the present war.

Treatment: Descriptive and expository. Pages, 24.

Paper No. 207. Present Condition of the Submarine.

By Max A. Laubeuf.

Subject Matter: The beginnings of submarine navigation, U. S. 1776; first military submarine, 1887, France; experiments of Holland, Lake, Pullino; "submersible" type. Submarine and submersible differentiated: mode of construction, water ballast tanks inside vs. outside. Reserve of buoyancy, low vs. high; form of body, circular vs. torpedo-boat section; changes from surface to under-water navigation, time required for immersing; general adoption of submersible type. Present development of submarine navigation: numbers built by various nations; prevailing types of submarine—Electric Boat Co., Vickers & Co.; submersible—Laubeuf, Germania-Krupp, Laurenti; other designs. Increase in displacement: examples cited; drawbacks; speeds. Two distinct types: (1) defensive or coast-guard submarine—characteristics, common use, examples; (2) squadron submarine—must replace destroyer type, offensive power, nautical qualities, speed insufficient, half measures useless, maximum power with minimum weight, double motor, debt to storage battery, internal-combustion engines. Military uses of the submarine: (1) defense of coasts; (2) preventing attempt at blockade; (3) preventing disembarkation of troops; (4) demoralization of morale on ships subject to attack; (5) interference with commerce. Prophesies, opinions. Bibliography.

Treatment: Historical, descriptive and expository. Pages, 32. Illustrations, 13 diagrams and 5 half-tones.

Paper No. 208. Modern Marine Gun Armament.

By H. F. Leary.

Subject Matter: Development of dreadnaught during last seven years covers revolutionary changes in modern marine gun armament. Plans of

dreadnaught introduced new governing principle known as "all big gun" or "single calibre" versus armament of the "mixed battery". Reasons for adoption of new idea and for former policy; target practice shows that the larger the calibre the more accurate the shooting; additional reasons. Selection of calibre and type of gun for primary armament a subject of much controversy; fairly strong current of opinion favors increasing calibre; reasons attributed. Augmentation of striking power necessitated by increase in battle ranges and improvement in armor; ways of accomplishing. Use of high explosives in armor-piercing projectiles. Range of calibre of primary armament. Arrangement of batteries to get maximum fire efficiency; results obtained by various nations; controlling factor in American practice. General conditions governing primary armament of modern capital ships summarized. Methods of handling ammunition; tendency towards adoption of electrical machinery. Two general systems used in turret loading. Advantages and disadvantages of "Director" method of firing. Arrangements of ammunition supply. Breech mechanisms. Erosion, causes and remedies. Muzzle droop and effects. Secondary battery, guns and armament. Aerial defense. Armament of submarine vessels.

Treatment: Descriptive and expository. Pages, 17.

Paper No. 209. The General Problem of Naval Warfare.

By D. W. Knox.

Subject Matter: Army and Navy not alone concerned in war. Public opinion permits war only when national honor imperiled or vital interests jeopardized; relation of vital interests to the "Great Arbiter" discussed; control of Panama Canal, Dardanelles, Bosphorus; problems of European nations. War and diplomacy: treaties, preparedness and potential force; war one phase of diplomacy; war continuation of diplomatic battles. The statesman and the warrior; duty of government to provide for national defense; preservation of national existence a national affair; council of national defense for peace preparation only; experience of U. S. during Civil War; war policies should be clearly defined in advance; principle of survival of strongest and fittest applies to nations. Strategy defined as "Art of using battles in war"; functions of diplomatic and other civil branches of government important part of general problem of naval warfare; peace strategy; function of General Staff; method of upholding Monroe Doctrine; fleet position, bases, mobilization, getting there first; information about hostile forces, assistance from ashore, scouting, screening. Tactics: concentration; function of destroyers, submarines, mines; the Main Day action—annihilation of opponents, principal object; concentration, key to success; battleships, principal weapon; time of vital importance; broadside fire; maneuvering; division column movement; line of bearing; T situation ideal; battle cruisers; torpedo attacks. Command: high qualities demanded; expertness essential; con-

tinued study of changing conditions required; indoctrination; loyalty, morale. Bibliography.

Treatment: Expository. Pages, 25.

Paper No. 210. Marine Steam Boilers and Boiler Room Equipment.

By Chas. F. Bailey.

Subject Matter: No revolutionary invention during last decade made in field of marine boiler and boiler room equipment, nevertheless many important improvements in design, construction and operation. General discussion of Scotch boilers regarding leading characteristics of design and construction. General discussion of water-tube boilers of specific types regarding leading characteristics of design, construction and operation; water-tube boilers with special reference to mercantile practice; the Niclausse boiler; White-Forster boiler; Normand boilers; the box type of boiler; Drum type of boiler; Thornycroft boilers; Yarrow boilers; Babcock and Wilcox marine boilers. Superheated steam: the Foster superheater; the Babcock and Wilcox superheater; Yarrow superheater; the Robinson type of superheater; the Schmidt superheater. Arrangement of fire room. Boiler room piping, valves, etc. Boiler room communication: telegraph systems; firing indicators; smoke indicators. Analysis of flue gases. Handling of refuse and ashes. Mechanical and natural draft. Boiler feed pumps. Feed-water heaters. Boiler corrosion. Bibliography.

Treatment: Descriptive. Pages, 58. Illustrations, 15 inserts, 10 half-tones and 16 line cuts in text.

Paper No. 211. The Development of the Marine Steam Turbine.

By H. C. Dinger.

Subject Matter: Chronology. Types proposed, many; successful, few. Two basic types, impulse and reaction; Curtis, Parsons; characteristics. Tendency toward one type. Relative advantages: impulse, reaction. Backing and maneuvering power, difficulties. Cruising turbines, results. Combination of impulse stages at high-pressure end. Applications: arrangement of turbines on naval vessels; on merchant systems. Reduction systems: electric drive; hydraulic transmitter; gearing, efficiencies, advantages. Advantages that the application of the marine turbine has secured for commercial vessels and for naval vessels—economy, cost, space, vibration, oil. Present and future applications: for naval vessels—capital ships, destroyers and scouts; for commercial vessels—fast passenger vessels and yachts, slow and moderate-powered merchant vessels. Economy: lack of economy at low speeds. Superheat. Difficulties experienced: Parsons, Curtis, Zoelly; rusting of interiors: Incidental influences; vacuum, propeller design.

Treatment: Descriptive. Pages, 29. Illustrations, 9 diagrams and 2 half-tones.

Paper No. 212. The Application of the Steam Turbine to Marine Propulsion.

By J. F. Metten.

Subject Matter: Turbines coupled direct to propeller shafting. Turbines and mechanical reduction gear. Turbo-electric transmissions. Hydraulic transformers or transmitters. Reciprocating engines and turbines in combination; description and comparison of various arrangements, applications and installations. Comparative performance of different systems, with table showing losses compared and analyzed.

Treatment: Descriptive. Pages, 23, with 14 diagrams.

Paper No. 213. Recent Developments in Marine Engineering in Japan.

By Masayoshi Tsutsumi.

Subject Matter: Ship-building Encouragement Acts promulgated in 1896. Early types of marine engines built in Japan. General condition of the art of marine engineering in Japan at the time of the Japan-China War. Number of vessels and aggregate horse-power constructed under Encouragement Acts. Total horse-power built by principal firms in Japan during years 1897-1904. Principal dimensions and characteristics of typical large marine engines built in yards of Japan. Introduction of steam turbines, with principal characteristics of certain illustrative examples. Combinations of reciprocating engines and Parsons' low-pressure turbines. Introduction of Howden's forced draft; water-tube boilers; superheated steam; oil fuel.

Treatment: Descriptive. Pages, 12, with 4 inserts giving tabular information.

Paper No. 214. Oil Fuel.

By Ernest H. Peabody.

Subject Matter: Use of oil fuel for marine purposes practically confined to production of steam. Early beginning of oil industry. Epoch-making discovery of oil at Spindle-Top, followed by great activity in oil burning. British Navy inaugurates use of mechanical atomizers for securing high boiler capacity. Statistics of oil production; amount and character available for fuel. Wide distribution of fueling stations. Oil tankers for transporting oil. Comparative cost of oil, and advantages of using it. Ease of converting vessels for burning oil; approximate cost. Physical properties of oil. Necessity for heating viscous oils recently introduced on the market. Importance of viscosity and methods of determining and reporting it; need of common standard. Danger of heating above flashpoint; possibility of obtaining a "safe" oil. Storage of oil on shipboard. Measurement of oil. Precautions against danger. Pumps, heaters, strainers, piping, etc. Corrosion due to oil. Early

methods of burning; types of atomizers compared. Advantages and economy of steam atomizers. Description of American types of mechanical atomizers and methods of air control. Automatic control. Coal and oil in combination. Furnace design, importance of furnace volume. Limitations of draft. Individual burner capacity. Test results and other data. A glance backward. Trend in the immediate future.

Treatment: Descriptive. Pages, 131. Illustrations, 8 inserts, 18 half-tones and 26 line cuts in text.

Paper No. 215. The Application of Diesel or Heavy Oil Engines to Marine Propulsion.

By G. C. Davison.

Subject Matter: Two-cycle vs. four-cycle; comparison, with relative advantages and disadvantages. Size limitations. Two general classes on basis of weight. Successful applications; developments and use by various nations. Adaptations. Extent of industry. Builders. Fuel economy controlling factor. Conditions in Europe and America. Essential data. Worst enemies. Dangers.

Treatment: Descriptive and expository. Pages, 18. Illustrations, 1 diagram, 6 half-tones and 1 insert.

Paper No. 216. Diesel Engine Applied to Marine Purposes.

By C. Kloos.

Subject Matter: Early Russian use; Nobel Bros. interests. Werkspoor Works. Early designs, "Vulcanus", description, results. Fuel feeding. Results, motor vessel and steamer compared. Performances of many other motor vessels described. Deck machinery and auxiliaries. Fuel question.

Treatment: Descriptive. Pages, 35. Illustrations, 4 diagrams, 9 half-tones and 1 insert.

Paper No. 217. Cargo Handling Methods and Appliances.

By H. McL. Harding.

Subject Matter: Objects of paper to discuss cargo-handling methods best adapted to reduce ship's detention; to produce maximum return on investment with minimum charges; to change present methods so that handling cost at terminals will not exceed cost of water carriage. Vessels and shore appliances. Cargo classifications: miscellaneous, bulk. Nomenclature. The marine terminal. Cargo transferring and handling methods: transferring mechanism on ship; influence of the design on the vessel on transference; ships for special commodities; special appliances; steam winch; burtoning; increased size of ships; side ports: costs per ton

handled by manual labor; speed of transference; dimensions of freighters; reducing ship's detention. Shore appliances and terminal design and layout: principles of marine terminal design; shed capacity and tiering; warehouse functions. Various types of cranes; gantry jib-crane specifications; traveling hoist cranes; other hoisting and conveying appliances. Bulk material cargoes. Coal handling plant for the Panama Canal. Ore and coal. Belt conveyors. Conclusions. Bibliography.

Treatment: Descriptive and expository. Pages, 29. Illustrations, 2 diagrams and 12 half-tones.

Paper No. 218. Cargo Handling Methods and Appliances.

By James A. Jackson.

Subject Matter: World's commerce, magnitude of the subject emphasized. Classification of freight: bulk, live, package. Past methods of freight handling. Present methods of cargo handling. Future trend. Suggestions for improving cargo-handling methods. Power for cargo-handling machinery. Conclusions.

Treatment: Descriptive. Pages, 12.

Paper No. 219. Some Economic Fundamentals of Freight Handling.

By David B. Rushmore.

Subject Matter: World's activities classified: production, transportation, consumption. Storage. Some of the necessary commodities of life. First and second place in the production of staples. Individual requirements. World figures for population and production. Raw materials, sources and products. Weight and density of freight. Containers for package freight. Size of freight goods. Freight traffic of the United States. Average density of marine freight. Average cost per ton mile. Some typical costs of terminal freight handling. Carriers of freight; public carriers. Freight-handling apparatus. Typical ships' manifest. Typical L. C. L. freight car. Classification of freight terminals.

Treatment: Descriptive. Pages, 30. Illustrations, 10 diagrams and 9 half-tones.

Paper No. 220. The Modern Trend in American Marine Terminals.

By Robert H. Rogers.

Subject Matter: Most desirable lines of terminal progress: safety, dispatch, economy, service. Safety: compulsory piloting, dry-docks and marine railways, car-floats, electric yard locomotives, working conditions, sanitation, fire protection, room for improvement. Dispatch: winches, conveyors, cranes. Economy: industrial trucks, car-pullers, portable cranes, automatic weighing machines, good lighting system, adequate

power distribution, battery charging devices, tools. Services: warehouses, the fly-wheels, equalizers in handling methods, service bettered through business relations.

Treatment: Descriptive and expository. Pages, 15.

Paper No. 221. American Graving Dock Practice.

By Leonard M. Cox.

Subject Matter: Increased size of dry docks during last decade made necessary by marvelous growth of ships. Provision of adequate means for cleaning and repairing enormous floating structures present increasingly different problems. Construction of each dry dock involves new problems because of varying conditions. Review of methods used in principal American structures built in last decade, with summary of American practice regarding the most important features and examples of docks constructed or projected during that period, with table of dimensions and other data. Discussion of salient features of design, based on the study of constructions built or projected and upon an estimate of future requirements. Choice of type; site; essential features; general discussions; number of sills; closure; head; altars; lining; floor drains; floor; blocks; caisson grooves; flooring; fittings; stairs, cranes; pumping plant and structural design.

Treatment: Descriptive and expository. Pages, 30, with 20 diagrams and 1 insert table.

Paper No. 222. Dry Docks Recently Built in Italy.

By Luigi Luiggi.

Subject Matter: General information: reference to best and largest docks in Italy; dimensions of docks at Venice and Taranto; special features, methods and materials of construction. Floating caissons of special types, details and relatively low cost of construction; steel caissons readily operated; ferro-concrete caissons especially adapted to conditions in tropical countries. Conclusion: Italian Navy Yards provided with all requirements for docking ships up to 800 feet in length and 110 feet in width, with ship in any condition.

Treatment: Descriptive. Pages, 8, with 6 diagrams.

MISCELLANY.

Paper No. 223. The "Arrival" of the Aeroplane.

By Algernon E. Berriman.

Subject Matter: The aeroplane for reconnaissance and direction of artillery fire; the British Government's recent contracts. Manufacture as distinct from design; automobile factories equipped for aeroplane build-

ing; Gnome rotary motor. The non-military aeroplane of war; real fighting aeroplane not yet in existence. Aeroplane resistance: air resistance; stream-line forms; national research and private enterprise; the work of the wings; aerodynamics and frictional resistance; the regulation of speed; the virtue of a cambered wing. The power required for flight. Control and stability: the organs of direction and control; stability; gliding experiments in 1884; the effect of wind-gusts; lateral stability by the use of vertical fins. Bibliography.

Treatment: Descriptive and expository. Pages, 35, with 9 diagrams.

Paper No. 224. A Discussion Concerning the Theory of Sustentation and Expenditure of Power in Flight.

By F. W. Lanchester.

Subject Matter: A resumé of investigations relating to flight. Skin or surface-friction; mathematical laws relating to skin-friction. Direct resistance as related to skin-friction; total resistance never less than the skin-friction; the "bluffness" effect prevents the full influence of skin-friction from being developed. The skin-frictional basis of computing the direct resistance justified by experience. Resistance of the inclined plane lamina. Sustentation in flight: author's theory of sustentation in flight based on general theory of vortex-motion; reference to screw-propeller and vortex theory; curves relating to propeller thrust.

Treatment: Expository and mathematical. Pages, 24, with 12 diagrams.

Paper No. 225. Experimental Researches in France on the Resistance of Air.

By L. Marchis.

Subject Matter: Classification of experimental methods: reactions exerted by the air on a body in relative movement with it; manner of producing the movement of a body relative to the air which surrounds it, body movable; manner of producing the movement of a body relative to the air which surrounds it, artificial current of air; studies of aeroplanes in free flight; the total resistance of the air and the determination of the pressures at each point of the surface of the body under investigation. The aerodynamic laboratories of France: the Eiffel laboratories, experiments made at the Eiffel Tower; the Eiffel laboratory, method by the use of an artificial current of air; the Aerotechnic Institute of Saint-Cyr; the laboratory of M. de Guiche; the laboratory of Chalais-Meudon and the experiments of M. le Commandant Dorand; the aviation laboratory of Vincennes and the experiments of Captain Olive; the experiments of Commandant Lafay at the physical laboratory of the Polytechnic School; aerodynamic studies performed in other laboratories. Diagrams representing the results of experiments: proposed notations; study of the

wings of an aeroplane, polar diagrams of M. Eiffel; study of the horizontal movement of an aeroplane, the logarithmic polar curve; the characteristic coefficients of propellers according to G. Eiffel; study of the properties of propellers, the logarithmic diagram of M. Eiffel; study of the properties of propellers, the diagram of the Aerotechnic Institute of Saint-Cyr. The results of experiment: within what limits may the results of experiments made on models be applied to full-sized machines; the displacement of a body under test through the air and the movement of the air with respect to a fixed body; the aerodynamics of the plane, planes orthogonal; aerodynamics of the plane, planes inclined to the direction of relative movement and isolated; aerodynamics of the plane, planes in tandem; aerodynamics of plane aerofoils, arranged stepwise; aerodynamics of curved aerofoils, isolated; aerodynamics of curved aerofoils, combinations of curved aerofoils, arrangement in biplane; the aerodynamics of curved aerofoils, combinations of curved aerofoils, aerofoils in tandem; the apparatus of aviation; propellers at a fixed point; propellers advancing relative to the medium; study of the medium surrounding a screw propeller; influence on the operation of a propeller of a current of air perpendicular to the axis of rotation. Bibliography.

Treatment: Descriptive and mathematical. Pages, 99. 1 insert.

Paper No. 226. A Review of Hydrodynamical Theory as Applied to Experimental Aerodynamics.

By J. C. Hunsaker.

Subject Matter: Review of the principal conclusions to be drawn from the motion of a perfect fluid: steady motion; stream lines; Bernoulli's equation; Pitot tube; Venturi tube; hot-wire anemometers; source and sink, lines of force, Ahlborn's photographs; discontinuity; cyclic motion and vortices; vortex theory of sustentation. Real fluids: effects of compressibility; density; viscosity, Prandtl's boundary layer, resistance of objects. Corresponding speeds and the theory of dynamical similarity. Principal conclusions to be drawn from mathematical theory. Illustrations taken from motion of real fluid under approximately similar conditions. Extensive references to the literature of hydrodynamical theory and experimental aerodynamics are given in connection with text. Bibliography.

Treatment: Expository. Pages, 48. Illustrations, 15 half-tones and 12 line diagrams in text.

Paper No. 227. The Development of Refrigeration in the United States.

By J. F. Nickerson.

Subject Matter: Recent large growth of refrigerating industry within the time of the present generation. Brief historical sketch of evolution

of mechanical refrigeration. Special characteristics of progress during past 25 years. Organization of American Society of Refrigerating Engineers. Special features of development and improvement with special reference to ammonia machines. Characteristic features in connection with manufacture of artificial ice. Domestic refrigeration. Precooling and refrigeration of perishable fruit in transit. Ocean carriage of refrigerated meat. Cold storage warehouses. Refrigeration in the general industries.

Treatment: Historical. Pages, 25.

Paper No. 228. Refrigeration in Sweden.

By Thor Andersson.

Subject Matter: Small relative demand for refrigeration in Sweden. Exceptional knowledge of rational methods of dairying. Ice method for creaming. Importance of refrigerating in the brewing industry. Technical characteristics of Swedish practice in the construction of refrigerating machinery. Construction of refrigerating establishments by Swedish companies outside the boundaries of Sweden. Miscellaneous application of refrigeration in the arts.

Treatment: Descriptive. Pages, 3.

Paper No. 229. Refrigeration in France.

By L. Marchis.

Subject Matter: The technique of very low temperatures: production of liquid air; separation of the oxygen and nitrogen of the air; special circumstances presented by the liquefaction of air (mixture of oxygen and nitrogen); the separation of oxygen and nitrogen can not be realized when, in the liquefaction of air, the liquid and gaseous phases are maintained in contact; distillation of liquid air under constant pressure; condensation of air under constant pressure with elimination of the liquid phase; the counter-flow method of Mons. G. Claude; the preparation of pure oxygen and of nitrogen 97% or 98% pure; the preparation of nitrogen with 0.2% oxygen; the preparation of hydrogen; the extraction of the rare gases in the atmosphere; liquid oxygen employed as an explosive; production of temperatures down to –211 C by the use of liquid nitrogen; recovery of volatile liquids (method of M. Claude). Heat insulators. Refrigerating machines: capacity and performance, definitions and formulæ; the construction of refrigerating machines in France. The applications of refrigeration: the traveling refrigerating plant of the French Association du Froid; refrigeration in the wine industry.

Treatment: Descriptive and expository. Pages, 31, with 1 insert giving tabular information.

Paper No. 230. Some Observations on the Extent and Value of Farm Power Equipment.

By Philip S. Rose.

Subject Matter: Horses and mules the farmer's principal source of power; census of 1910 showed over 24,000,000 horses and mules on farms in the United States; other census data for 1914. Cost of horse-power and mechanical-power compared. Chart showing improved acreage for each work-animal; chart showing improved acreage by decades since 1850; chart showing number of horses in the United States by decades since 1870. Number of horses depends upon farmer's ability to feed them. Lands not plowed deep enough; table showing data on depths and widths of furrows and corresponding draft in pounds required. Not the initial price of a horse but its equipment and maintenance that are the important expenses. Size of power-units and influence on cost of crop production. Chart showing average values of horses and mules since 1899; chart showing highest and lowest prices paid for horses in Omaha stock market since 1899. Horse population of the world being depleted by the European War. Power-driven machines a necessity for many kinds of farm work; table showing power required to operate principal farm and household machines. Use of windmills, their number and power capacity. Steam and gas engines. Development of the tractor; the light-weight tractor. Steam engines for threshing. Portable gas engines. Automobiles and trucks on the farm. Table showing data of power costs for various kinds of power on the farm.

Treatment: Statistical and expository. Pages, 18, with 5 diagrams.

Paper No. 231. Agriculture and the Engineer.

By J. B. Davidson.

Subject Matter: Data from U. S. Census on farm and industrial investments. Table showing investments in farm machines, value of farm crops and of mature horses and mules per capita of rural population. Influence of machinery on cost of farm labor. Increase in area of agricultural land in the United States must come through reclamation of now worthless areas, either by drainage or irrigation; estimated that total area of land reclaimed by drainage is now 32,000,000 acres and by irrigation 20,000,000 acres. Estimated that 74,000,000 acres may be reclaimed and 250,000,000 acres made more productive by drainage, and that, with the water available for it, 50,000,000 acres may be reclaimed by irrigation. Importance of the road problem. Great value of agricultural engineering in its various branches. Demand for agricultural engineering and education for it; field for graduate agricultural engineers. Bibliography.

Treatment: Descriptive and expository. Pages, 11.

Paper No. 232. Technical Education for the Professions of Applied Science.

By Ira N. Hollis.

Subject Matter: Training for workmen. Training for a profession. The vocational school or trade school. "Broad" education; specialty leads toward narrowness. The technical school and the college. The teaching of mechanical engineering; practical shop work and book courses. Teachers usually not experienced in real manufacturing. Real shop work in Worcester Polytechnic Institute; the power of application and work is the object of a school; theory is studied only once, whereas practice can be obtained continuously afterward; purpose of the founders of the Institute. Professions begin as occupations; engineering and agriculture were oldest occupations. Four methods open to those entering an engineering profession. The fundamental subjects are the applied sciences—courses over-crowded rather than over-loaded. Schedule of studies in American schools of applied sciences. Charts showing schedule of hours required for subjects. Freedom of choice; elective courses. Competition of trade has crept into our schools; effect of salaries paid. Outside work for professors.

Treatment: Expository and descriptive. Pages, 20, with 8 diagrams.

Paper No. 233. Some Considerations Regarding Engineering Education in America.

By Geo. F. Swain.

Subject Matter: The general tendency of engineering education. Value of self-education. Pioneer professional schools in America; early European professional schools. Curriculum of Rensselaer Polytechnic Institute of date, 1826; of Sheffield Scientific School (Yale University) of the year 1852-53. The effect of French and German technical schools. First electrical engineering course in America at Massachusetts Institute of Technology in 1883-84. Beginning of the laboratory method. Increasing number of studies to be pursued; wisdom of later methods of teaching questioned. Subjects once considered important now omitted. Education of exceptional versus ordinary men. Engineering rests upon mathematics and actual sciences and mechanics. Suggestions as to proper direction in which engineering schools should develop. Probable that better opportunities now offered in America (1913) for engineering education than in Europe.

Treatment: Historical and expository. Pages, 14.

Paper No. 234. Scientific and Engineering Improvements in the Heating and Ventilating Art.

By Rolla C. Carpenter.

Subject Matter: Improvements of the scientific foundation of the art of heating and ventilation; better understanding of fundamental

laws; interrelation between heating and ventilation; investigations regarding amount of heat required to maintain enclosures in buildings at any desired temperature. Scientific developments in the art of ventilation; influence of carbon dioxide on health and comfort; investigations regarding results of varying degrees of humidity, effects of noxious gases, odors and other accidental constituents of the air. Engineering and mechanical development in the art of heating. Development of the art of air conditioning: the cooling of rooms; dust and smoke removal.

Treatment: Expository and historical. Pages, 9.

Paper No. 235. Recent Developments in Heating and Ventilation.

By D. D. Kimball.

Subject Matter: Recent developments and requirements in connection with the heating and ventilating of buildings. Work of the New York State Commission on ventilation. Recent recognition of the status of CO_2 as a factor in the problem of ventilation. Conclusions of New York State Commission regarding the influence of the chemical constituents of the air of an occupied room. Humidification of air. Ozonization of air. Presence of trade dust as a factor in ventilation. Importance of air movement in connection with ventilation. Temperatures for air introduced for purposes of heating and ventilation; artificial cooling; high costs of artificial cooling; necessity of proper rational management and skill in operating any system of artificial heating and ventilation. Mechanical appliance for use of heating and ventilating engineers. Reference to multi-blade fan and air washing.

Treatment: Historical and expository. Pages, 18.

Paper No. 236. Vacuum, Vacuo-Vapor and Atmospheric Heating Systems.

By James David Hoffman.

Subject Matter: Earliest steam systems produced circulation by increasing the pressure on the supply, while at the present time the tendency is to reduce pressure on the return. Tendency in heating development: (1) A gravity-return system is the basis of the modified systems of recent years; this is not well adapted to light, continuous service; (2) low-pressure steam, air-line vacuum, gravity-return system used on residence plants; (3) low-pressure steam, air-line continuous vacuum, gravity-return system used on medium large capacity plants; (4) low-pressure steam, return-line continuous-vacuum pump-return system used on plants of medium and large capacity; (5) near-atmospheric pressure, gravity-return system used on residences; (6) atmospheric-pressure gravity-return system is the most recent tendency toward simplicity and is used on residences. Classification of systems; trade names of typical systems. Vacuum System: Mechanical vacuum—air and condensate combined, seven advantages of this system, system in

detail; the Webster vacuum system; the Dunham system; the Monarch system; the automatic vacuum system; and the Reliable system. Air and condensate separate—the Paul system; the Sparks one-pipe air-line system. Vacuo-vapor systems: the Moline system; the mercury-seal system and advantages; the Eddy system. Atmospheric systems: their characteristics and regulation; the Broomell system; the Reliable system; the mercury-seal graduate system; the Illinois thermal modulating system; and the Webster modulation system. Special fittings: thermostatic valves; float valves; nozzles and vacuum producers. High-pressure systems used only in places where it is necessary to maintain a high temperature differential. High-vacuum systems used to overcome high hydraulic-head.

Treatment: Descriptive and expository. Pages, 33, with 41 diagrams.

Paper No. 237. Development and Progress in Scientific Management During Recent Years.

By E. P. Lesley.

Subject Matter: Definition of the term "scientific management" as used in present paper. Principles of the Taylor system of management as set forth in 1903. Evidences indicating progress in scientific management during last decade. Application of the system of scientific management: Mr. Taylor's paper on "The Art of Cutting Metals"; factors involved in the application of the system to specific cases. Popular interest in the subject. Attitude of organized labor. Government action. Scientific management and the college. Improvements in methods and devices. Societies. Literature.

Treatment: Historical and expository. Pages, 23.

Paper No. 238. Industrial Management.

By A. Hamilton Church.

Subject Matter: Definition of the term "industrial management" as used in present paper. Recent tendencies in the evolution of industrial management. Elements involved in the study of industrial management. Management viewed as a synthesis of functions; principal functions: design, equipment, control, comparison and operation. Characteristics of modern engineering and industrial design. The function of standards. The characteristics and function of equipment. The function of control as a directive agency. The function of comparison as an aid in the guidance and application of control. Operation viewed as the act of applying labor and material in such manner as to transform the latter in accordance with dictates of design. Fundamental laws of action or effort which lie at the foundation of all management. Present condition of the science or art of "industrial management."

Treatment: Expository. Pages, 26.

Paper No. 239. Motion Study and Time Study Instruments of Precision.

By Frank B. Gilbreth and Lillian Moller Gilbreth.

Subject Matter: Excessive waste resulting from needless, ill-directed and ineffective motions. Fundamental elements in every measurement. Time study viewed as "the process of analyzing an operation into its elementary operations, and observing the time required to perform them". Motion study viewed as dealing with the selection, invention, and substitution of the motions and their variables that are to be measured. Instruments available for real status of time and motion studies. Need of greater refinements in order to meet modern conditions. Modern instruments available for the present student of time and motion study: the cyclegraph; the stereocyclegraph; the stereochronocyclegraph. Time and expense involved in carrying out time and motion studies under modern conditions with modern equipment.

Treatment: Expository. Pages, 14, with 9 half-tones in text.

Paper No. 240. The Status of Engineering in Chile.

Submitted by The Institute of Engineers of Chile.

Subject Matter: Engineering education: sources of study and present status. The organization of the Division of Public Works: the various sections and subdivisions of public works with duties of the various branches. Public water supply: description of systems employed and statement of costs of principal installations. Waterways and harbor improvement: brief description of important developments with statements of costs. Irrigation works: brief statement regarding controlling conditions; description of principal systems; statement of area irrigated. Hydraulic power: possibilities of development of hydraulic power; brief description of principal developments. Railroads of Chile: construction by the State; private railway lines; brief description and standards of principal systems. Operation of state railroads: tabular showing of freight charges and passenger charges on the state railroads. Cartography: statement of principal work thus far accomplished and of work at present in hand and contemplated. Materials of construction: distribution and characteristics of principal materials, mineral and timber. Highway bridges: bridges commonly employed; stages in the evolution of highway bridge construction in Chile; relative use of steel, concrete and wood; costs of highway bridges. Highways: principal materials and methods employed. Pavements; materials and methods employed. The office of geography and mines: scope of the duties of this office; principal studies thus far completed and in hand; reconnaissance work with reference to the finding of petroleum and water.

Treatment: Descriptive. Pages, 55.

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Churchill, Chas. S.	71	Railways	48	Discussion
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